Application for License Renewal Materials License No. SNM-1373 December 6, 2021

License Re-Application – Idaho State University, Pocatello ID 83209

Certified ORIGINAL by: [signature] Osiris Siurano-Pérez December 16, 2021

Table of Contents

Application for License Renewal
Materials License No. SNM-1373
December 6, 2021

Table of Figures

Application for License Renewal
Materials License No. SNM-1373
December 6, 2021

1. Introduction

This application documents Idaho State University's request to renew SNM license 1373 for a period of ten years. It provides information required in 10 CFR 70 Subpart D and addresses the review topics of NUREG-1520, Revision 2.

2. Information about the Applicant [ref. 10 CFR 70.22(a)(1)]

Name:	Idaho State University
Address:	921 S. 8th Avenue, Pocatello, ID 83209
Description of Business or Occupation:	Institution of Higher Learning

The Idaho State University (ISU) is operated by the State of Idaho with its principal office at Pocatello, Idaho. The Idaho State Board of Education provides oversight and direction of the higher education institutions in Idaho and is located in Boise, Idaho, (P.O. Box 83720-0037).

Positions in the Roster of Officials

- President of the University
- Vice President for Research
- Chairperson of the Reactor Safety Committee
- Radiation Safety Officer
- Chair of the Department of Nuclear Engineering
- Reactor Administrator
- Reactor Supervisor

The current President of the University has designated the Vice President of Research as the university official who has overall responsibility for this license. A roster of current university officials with complete contact information is provided in Attachment (I). The information given in this attachment may be subject to change due to personnel reassignments. Such changes will require that only the information in Attachment (I) be updated as necessary by notification of

NRC. There is no control or ownership exercised over the application by any alien, foreign corporation, or foreign government.

3. Location of Material and Activity for Which It Will Be Used [ref. 10 CFR 70.22(a)(2)]

The Special Nuclear Material (SNM) in this license is used for education, research, and training programs. This license re-application specifies the same total mass of [redacted] of U-235 rounded up to the nearest gram as was specified in the previous license: [redacted] of U-235 are contained in [redacted] uranium-aluminum fuel plates and the remaining U-235 is [redacted] contained in a fission counter and [redacted] in [redacted] uranium-aluminum foils.

3.1. General use plan for the requested SNM

The SNM is used primarily for instructional purposes in senior and graduate-level laboratory courses. The fuel plates are used primarily to create a subcritical assembly (SCA) in which they are loaded in various lattice arrangements in a water-filled tank. The fuel plates may be used singly for a quasi-homogeneous assembly or in groups of two or more to produce a more homogeneous configuration.

Some of the experiments to be carried out with the subcritical assembly are:
Approach to critical
Flux distribution measurements
Exponential pile measurements
Fermi age determination
Determination of optimal cell dimensions of a heterogeneous subcritical assembly
Effect of fuel-plate thickness on multiplication factor

The uranium-aluminum foils may be used as neutron monitors in some experiments performed with ISU's AGN-201 nuclear reactor. The uranium-aluminum foils have too small a U-235 content to be usefully activated in the subcritical assembly.

In addition, research programs utilizing the materials will be encouraged. For example, fuel plates and uranium-aluminum foils may be used as sources of fissile material for research and development of advanced methods for nondestructive assays and evaluation (NDA/NDE) of fissile material content in various configurations. The uranium-aluminum foils would be used to monitor neutron flux levels, and the fuel plates would be used to represent fissile material in

various shipping arrangements to investigate effectiveness of NDA/NDE interrogation techniques.

All experiment procedures are reviewed by the Reactor Safety Committee prior to execution. No experiments or activity involving the use of the SNM will be performed without the prior approval of the Reactor Administrator or Reactor Supervisor.

3.2. The place in which the activity is to be performed

The SNM will be used exclusively in the Lillibridge Engineering Building (LEL). The Nuclear Engineering Laboratories are in the basement of the Lillibridge Engineering Laboratory Building. This facility has approximately 30,000 square feet, on three floors (including the below ground level basement). Exterior wall construction is all brick. Floors, on all three levels, are reinforced concrete.

The SNM will be stored, and used, primarily in Room [redacted] (The Subcritical Assembly Facility), approximately 400 sq. ft. in area, in the basement of the Lillibridge Engineering Laboratory building at Idaho State University.

[redacted] There is no standpipe system for the building. However, water pressure in the municipal system for Pocatello is maintained by large storage tanks at an elevation of approximately 150 to 200 feet above the level of the LEL building. Fire hydrants are on campus for use by the Pocatello Fire Department, the nearest dispatch station being approximately 0.5 miles away.

A map of the ISU campus showing the location of the LEL building is shown in Figure 1: Campus Map - LEL is building #7 and Campus Security is #27. The LEL basement floor is shown in Figure 2. Room [redacted] is 20-feet by 20-feet square with a 12-foot ceiling. The floor is 40-inch-thick reinforced concrete slab. [redacted] The floor will safely accommodate the weight of the entire SCA. Room 23 is a controlled access area (CAA).

The material will be stored in a locked steel storage container in Room [redacted] when not in use. On the occasion when the fuel is being used in the SCA tank, procedures allow fuel plates to remain in the assembly tank (aluminum construction, 36-inch diameter, 36-inch depth). When stored unattended in this tank, the fuel is secured with a locked aluminum lid on the top.

Small amounts of the SNM, consisting of up to [redacted] of the U-Al foils and/or up to [redacted] of the fuel plates may be transported to locations adjacent to Room [redacted] for temporary one-day use. These alternate locations are (Figure 2) The Counting and Radiation Lab (Room [redacted]) and The Nuclear Reactor Lab (Room [redacted]).

During such one-day use, the material will be continuously in the custody of an authorized custodian, one of the Nuclear Engineering Department personnel with T&R status. These personnel include the Reactor Administrator, Reactor Supervisor, Nuclear Engineering Department Chair, or a trained SCA operator.

The material will not be stored overnight at the alternate locations but will be returned at the end of each day to the CAA, Room [redacted], for overnight storage [redacted].

3.2.1. The Counting and Radiation Lab (Room [redacted])

[redacted] The southwest corner of the room contains a small concrete vault where radioactive material is stored. This area is separately locked and controlled from the main room and will not be used to permanently store SNM on this license. The floor layout for the Lillibridge Engineering Building, including room [redacted], can be found in Figure [redacted]

3.2.2. The Nuclear Reactor Lab (Room [redacted])

A description of the Nuclear Reactor Lab (Room 20) can be found in the ISU AGN-201m Safety Analysis Report Section 3.2.1 located in ADAMS Accession number ML030350328.

4. Period of Time for License [ref. 10 CFR 70.22(a)(3)]

This license is requested for a period of ten (10) years, from the starting date of August 2021. It is expected that a request for renewal will be submitted at the end of that period.

5. Specification of the Special Nuclear Material [ref. 10 CFR 70.22(a)(4)]

5.1. Uranium-aluminum fuel plates

The sealed source fuel plates were fabricated in 1960 by M&C Nuclear, Inc., for Rutgers University, New Brunswick, New Jersey. Each plate consists of a uranium-aluminum (metal alloy) fuel zone completely enclosed by an aluminum clad. The manufacturer's specifications for the plates are as follows:

Total number of plates	[redacted]
Total mass of uranium	[redacted]
Enrichment of U-235	[redacted]
Total U-235 content	[redacted]
U-235 loading per plate	[redacted]
Overall dimensions of plate	[redacted]
Dimensions of uranium bearing portion of the plate	[redacted]
Cladding thickness	[redacted]

5.2. Fission counter and uranium-aluminum foils

Fission counter

The fission counter has an active length of 1.0" with an active diameter of 0.20". The counter contains [redacted] milligrams of uranium-235 [redacted] sealed into one end of a stainless-steel tube 40" long and 0.25" in diameter.

Uranium-235 mass	[redacted]
U-235 enrichment	[redacted]

Uranium-aluminum foils

The sealed source uranium-aluminum foils consist of a very small amount of uranium, highly enriched in the uranium-235 isotope, deposited in the center of an aluminum disk. A second aluminum disk is then placed on top and the outside contact area of the disks not containing uranium is sealed. Thus, the foils are each a sealed source containing a small amount of uranium-235.

Total number of foils	[redacted]
Uranium-235 mass	[redacted] **of U-235 per foil)**
U-235 enrichment	[redacted]

5.3. Neutron Source (either Pu-Be, Cf-252, Am-Be, or equivalent approved by the Reactor Safety Committee or Radiation Safety Committee) authorized under the ISU Broad Scope NRC License #11-27380-01.

Specifications for the fuel plates, fission counter, and uranium-aluminum foils were taken from the manufacturing report (Attachment III.)

6. Technical Qualifications of the Applicant and Staff [ref. 10 CFR 70.22(a)(6)]

Responsibility for the oversight, supervision, and operation of licensed activities will reside with the Responsible University Officer, Nuclear Engineering Department Chair, Reactor Safety Committee Chairperson, Reactor Administrator, Reactor Supervisor, and the ISU Radiation Safety Officer. Minimum qualifications of these positions are listed in Attachment (IV).

A roster of officials containing information for the current president of the university, vice president of research, chairperson of the reactor safety committee, the reactor administrator, the reactor supervisor, and the radiation safety officer who have responsibility for the oversight, supervision and operation of the uranium are included in Attachment (I). The individuals listed in Attachment (I) have previously been approved by the NRC. Their CVs are also included with this license submission as separate documents. CVs for new members will be submitted as new people fill these positions.

6.1. Reactor Safety Committee

The Reactor Safety Committee is one of Idaho State University's regularly constituted committees. Appointments to the committee are made by the Vice President for Research. The Reactor Safety Committee shall be comprised of at least five members knowledgeable in fields that relate to nuclear reactor safety, radiation safety, and radioactive material safety. The committee shall consist of the Chair, the Reactor Administrator (ex-officio), the Radiation Safety Officer (ex-officio), the Vice President for Research and at least two other members. The operating staff shall not comprise the majority of the members. The Reactor Administrator, Reactor Supervisor, and licensed reactor and senior reactor operators are considered operating staff.

The Reactor Safety Committee will review new procedures, substantial changes to procedures, and facility changes based on their broad technical knowledge and focus on safety of ISU personnel and the public during these reviews. In addition, the Reactor Safety Committee can consult experts at Idaho State University or at outside institutions if they have additional questions or concerns that aren't covered by the expertise of the members. For chemical safety issues, the reactor administrator will coordinate review with the ISU Environmental Safety and Health Department in accordance with Section 16.

7. Equipment and Facilities to Protect Health and Minimize Danger to Life and Property [ref. 10 CFR 70.22(a)(7)]

7.1. Equipment and Facilities

The subcritical facility at Idaho State University was originally designed by and placed in use at Rutgers University in New Jersey in the mid-1950s. It was declared surplus by Rutgers University about 1975 and purchased by and moved to Idaho State University, Pocatello, Idaho.

The subcritical assembly (SCA) tank is made of aluminum, ¼ inch thick side wall, with a 3/8-inch-thick base that is welded to the 36-inch diameter cylindrical side wall. A 3/8-inch-thick aluminum lid fits on the top of the tank and can be secured by padlocks. The tank is 39 inches high and sits on the base consisting of the stack of graphite blocks, 32 inches in height. The blocks contain some removable pieces that slide out, permitting the insertion of neutron flux monitoring foils.

Inside the tank fits a removable and nearly cubical lattice grid (Figure II-1 in Attachment II), 23 inches on a side. The lattice contains slots for the fuel plates, the slotted portion of the grid being 18 inches by 15 inches. Spacing between the fuel slots is 0.718 inches center-to-center. The slots are thick (wide) enough to accommodate up to three fuel plates stacked against each other.

The fuel plates, numbering [redacted] identical plates, are each [redacted] inches thick, [redacted] inches wide, and [redacted] inches. The fuel bearing region is an aluminum-uranium cermet, 2.75 inches wide, [redacted] inches long and [redacted] inches thick. The cladding is [redacted] inches thick aluminum, on both sides of the fueled region. Figure II-2 (Attachment II) shows the structure of the fuel plates.

The total amount of uranium in the [redacted] plates is [redacted], enriched to [redacted] uranium U-235 totaling [redacted]. There is a special source holder having the same outer dimensions as the fuel plates, except that it has a [redacted] diameter source tube inserted longitudinally at the center of the would-be fuel region.

Filling of the water tank is accomplished from a pump that takes the water from the storage tank and pumps it into the assembly tank. A normally closed solenoid valve in a separate drain line blocks the water from draining from the assembly tank. The controls for the pump and the solenoid are operated from a control console adjacent to the subcritical assembly tank. The wiring diagram for the controls, including the "criticality

alarm" (merely an alarm-equipped Geiger-Mueller detector), is shown in Figure II-3 (Appendix II). The piping diagram is shown in Figure II-4 (Attachment II). Five float switches are located inside the assembly tank to measure the water level in the tank.

7.2. Working area

See section 3: "Location of Material and Activity for Which It Will Be Used [ref. 10 CFR 70.22(a)(2)]"

7.3. Measuring and monitoring instruments

Beta, gamma, and neutron dosimeters provided by an NVLAP (National Voluntary Laboratory Accreditation Program) certified vendor are issued to staff working with the special nuclear material. Students and visitors will use pen dosimeters or equivalent while handling fuel plates or working around the SCA.

The following hand-held survey instruments will be used:

- GM Pancake-Type Detector (ludlum3/44-9 or equivalent)
- Zinc Sulfide based Alpha Contamination Detector
- Ion Chamber with Beta and Gamma Window (Ludlum 9 or equivalent)
- Neutron Dose Rate Meter (Ludlum 12-4 or equivalent)

A Ludlum 300 or equivalent gamma radiation monitor serves as a criticality safety alarm for the sub-critical assembly and the readout from the monitor is observable from the SCA control panel. The gamma monitor system will provide direct radiation readings during experiments and subsequent post-irradiation decay of short-lived fission products and induced activity.

In addition, to the instruments described above, the radiation safety department operates laboratory instruments (a liquid scintillation counter and a gas flow proportional counter) to support surveys involving special nuclear material.

All radiation detection instruments used in connection with this license shall be calibrated by the ISU Radiation Safety Office or qualified vendors in accordance with the ISU Radiation Safety Manual.

Beta/gamma and neutron dose rate survey instruments will be available to personnel to determine radiation fields during and following experimental operations. In addition,

contamination survey instruments are available to ensure no radioactive material has been released during sub-critical assembly experiments. The types of instruments available to personnel are described above.

7.4. Storage facilities and security measures

(This information is provided in the ISU AGN-201m Docket No. 50-284, Physical Security Plan, Section 5.)

7.5. Criticality Alarm System

This information is discussed in Section 8.6, "Inadvertent Criticality".

7.6. Water handling system

At the beginning of each experiment deionized water will be pumped from the storage tank to fill the assembly tank. At the end of each experiment the water will be drained out of the assembly tank and into the storage tank through a drain line near the bottom of the tank. An alternative experimental approach would be to pump the water into the tank after the SNM material is loaded with the desired SCA lattice. As the water level increases, the neutron multiplication (k_{eff}) can be measured as a function of moderator height.

A schematic diagram of the water handling system is provided in Figure II-4 of Attachment (II). The drainpipe will be opened and closed by a "normally opened" solenoid valve. In the event of a power failure, the pump will shut off and the drain valve will open so that any water in the tank will necessarily drain out of the assembly tank. Without water acting as moderator the neutron multiplication factor of the assembly will be extremely small. Power feeding the solenoid drain valve and the pump will first go through a double-pole normally-open solenoid switch. This switch will be held open if a signal is generated by the criticality alarm. In the event of an inadvertent criticality (an extremely improbable event) indicated by a radiation alarm on the criticality detector ($\geq$ 10 mrem/hr), power to the pump and the solenoid drain valve will be automatically cut off, causing water to drain out of the assembly tank. Further, the solenoid switch will be wired in such a manner than any attempt to disconnect the solenoid switch from the criticality alarm will result in loss of power to both the pump and the solenoid drain valve. The wiring diagram for this installation is shown in Figure II-5 in Attachment (II).

8. Proposed Procedural Requirements to Protect Health and Minimize Danger to Life and Property [ref. 10 CFR 70.22(a)(8)]

8.1. Administrative controls

The Reactor Administrator is responsible for the safe storage and use of the special nuclear material. The Reactor Safety Committee (RSC) has reviewed and approved plans, new procedures, and substantial changes to procedures for the usage of the material in the SCA. The Reactor Safety Committee shall review and approve all new experimental plans and procedures for the use of the licensed material prior to implementation. The Reactor Safety Committee shall review and approve all changes to existing experimental plans and procedures that may affect safety. The RSC was formed at the request of the NRC in 1968 to review and approve experimental procedures performed in the ISU AGN-201 reactor (License R-110, Docket No. 50-284). The Radiation Safety Officer shall review radiation dose data annually to ensure that doses are maintained ALARA and shall report the findings of the assessment to the Reactor Safety Committee.

There must be a minimum of two persons who have been trained to the Subcritical Assembly Procedure of Idaho State University, at least one person must have current Trustworthy & Reliability (T&R) status, in Room [redacted] whenever operations involving special nuclear material in the subcritical assembly are in progress. T&R status is defined in and assigned per ISU Administrative Procedure 2. Access to Room [redacted] will be controlled by key card access maintained by ISU Public Safety. Only the Reactor Administrator or their designee have access to add individuals to the key card access list. Access will be granted as follows:

> The Reactor Administrator, Reactor Supervisor, Radiation Safety Officer, and Reactor Safety Committee members will all be granted access upon assumption of the position. Other personnel, authorized by the Reactor Administrator and who have been granted T&R status, may be granted access to Room [redacted] as needed. The Reactor Administrator and the Reactor supervisor will control keys to the locks securing the fuel storage container and the assembly access cover.
>
> The Reactor Administrator and the Reactor Supervisor will control keys to the override locks that can bypass the electronic magnetic lock. These keys may be used in case of emergency.

Prior to working or handling licensed nuclear material, all personnel shall have received training or shall be under the supervision of persons who have received training in operating the Subcritical Assembly from the Reactor Supervisor or their designee.

Statement of qualifications for personnel responsible for the use of the special nuclear materials under this license are discussed in section 6, "Technical Qualifications of the Applicant and Staff [ref. 10 CFR 70.22(a)(6)] ".

8.2. Radiation Hazard

ISU maintains a comprehensive radiation safety program documented in the Radiation Safety Manual and directed by the Radiation Safety Committee and Reactor Safety Committee. The program is implemented by the Radiation Safety Department managed by the RSO. The Radiation Safety Department includes professional radiation safety staff members and technicians.

Applicable chapters in the Radiation Safety Manual include the following

2 Radiation Safety Commitment
3 Safety Conscious Work Environment
4 Organizational Structure and Authority
5 Roles and Responsibilities (Management, Radiation Safety Committee, Reactor Safety Committee, RSO)
6 ALARA Policy and Dose Limits
8 Radiation Safety Training
9 Radioactive Material Requirements (Shipment, receipt, inventory, labeling, leak tests)
10 Control of Areas and Postings
11 Control of Contamination
12 Surveys
13 Safe Work Practices (PPE, hygiene, engineering controls, shielding)
14 Radiation Safety Program Audits
15 Dose Measurement and Reporting (external dosimetry and internal dosimetry)
16 Radiation Monitoring Equipment
17 Radioactive Waste Management
18 Decommissioning of Laboratories and Facilities
20 Emergency Preparedness and Response
21 Radiation Safety Records

Radiation protection measures specific to operation of the sub-critical assembly are discussed below.

8.2.1. Control of Areas

The use areas for materials are managed as restricted areas and radiation use areas (materials) in accordance with the Radiation Safety Manual. All areas are posted Caution Radioactive Material and Authorized Personnel Only. Step off pads are not utilized because no dispersible materials are handled in SCA operations.

8.2.2. Personnel monitoring

Reactor personnel (reactor operators, certified observers, the reactor administrator, the reactor supervisor, graduate research and teaching assistants, and faculty) wear dosimeters that measure beta, gamma, and neutron dose from a NVLAP certified vendor. Over the past five years, no reactor personnel have received whole body dose greater than the limit for members of the public, 100 mrem in a year. Therefore, visitors and laboratory students are monitored with direct reading dosimeters or equivalent.

All personnel frisk gloves and hands after handling SCA fuel plates.

8.2.3. Material Handling

Dose rates from SCA fuel plates are minimal because of the low amount of fission produced. Therefore, personnel may directly handle the fuel plates. When handling fuel plates and fission foils, all personnel wear disposable gloves to protect the material and the workers if there is an unexpected leakage of radioactive material.

8.2.4. Radiation monitoring

Radiation levels (gamma and neutron) from the subcritical assembly are monitored as specified in the Subcritical Assembly Procedure after each fuel addition. If the combined dose rate (gamma and neutron) exceeds 2 mrem/hr at 30 cm, visitors and laboratory students are removed from the area. If the combined dose rate at 30 cm exceeds 5 mrem/hr, water is drained from the tank. Each time the fuel assembly is lifted from the water, the gamma exposure is measured and recorded.

Finally, a gamma radiation monitor (Ludlum 300 or equivalent) serves as a criticality monitor and is located on the wall approximately five feet from the subcritical assembly. If the detector measures an exposure rate of 10 mR/hr, the system will automatically drain the water from the system.

8.2.5. Leak tests

Ten percent (10%) of the fuel plates will be leak tested using standard swipes for alpha contamination following each experiment and during one of the bi-annual material inventories. In the second bi-annual inventory, 100 % of the fuel plates are leak tested. Leak tests following individual experiments will be performed when fuel is returned to the storage cabinet at the end of the experiment.

Ten percent (10%) of the uranium-aluminum foils will be leak tested in conjunction with the fuel plates following use and during one of the bi-annual material inventories. In the second bi-annual inventory, 100 % of the foils are leak tested. Leak tests will not be performed if the foils are stored in a sealed container with a tamper indicating device.

8.2.6. Surveys

A general area radiation survey and contamination survey will be performed after each experiment. In addition, a bi-annual confirmatory survey including a general contamination survey and radiation survey will be performed in Room [redacted], by the Radiation Safety Department in accordance with the Radiation Safety Manual.

Water samples will be analyzed for gross activity following each experiment series to detect possible damage to or defects in the fuel plates. Water samples will be analyzed by the Radiation Safety Department using a liquid scintillation counter. Action levels shall be defined by an H-3 activity greater than 20000 pico-curies per liter, the Environmental Protection Agency, Maximum Contaminant Level (40 CFR 141.66(d). If the H-3 concentration exceeds 20000 pCi/L or if positive radioactivity is detected at energy above that of tritium, the RSO will be notified.

8.2.7. Training

All reactor personnel who operate the sub-critical assembly complete initial ISU radiation safety training and, if necessary, annual refresher training in accordance with Chapter 8 of the Radiation Safety Manual and 10 CFR 19.12. ISU Laboratory students who participate in SCA experiments also receive ISU radiation safety training. For visiting students from DOE or other facilities, ISU will accept current comparable radiation safety training (e.g., DOE radiological worker training) in place of ISU radiation safety training. Additional training regarding ISU specific information may be given in accordance with the Radiation Safety Manual.

8.3. Radioactive Waste

All of the radioactive materials used in association with the sub-critical assembly are solid or sealed materials and are not dispersible. Therefore, radioactive waste is not expected. Any radioactive waste that is generated will be managed in accordance with

Chapter 17 of the Radiation Safety Manual which implements the requirements of 10 CFR 20 Subpart K. Waste may be decayed in storage, disposed by discharge into the sanitary sewer, or disposed by transfer to a licensed waste management facility depending on specific characteristics of the waste. All discharges to the sanitary sewer system will comply with the requirements of the City of Pocatello discharge permit in addition to NRC regulations in 10 CFR 20.

8.4. Radiation Safety Records

Radiation safety records are maintained in accordance with Chapter 21 of the Radiation Safety Manual. This chapter addresses storage of worker dose records, survey records, audits, program reviews, internal dose measurements, procedures and other radiation safety records. Current external dose records are maintained in the NVLAP dosimetry vendor database. All other records are maintained in the ISU Box cloud storage application.

8.5. Fire Hazard

No materials or chemicals will be stored in Room [redacted] that could present a fire hazard. Normal fire rules will be observed. There is a dry-chemical, "ABC"-class fire extinguisher located next to the door of Room [redacted]. Two other fire extinguishers are located nearby in the Nuclear Engineering Laboratory section of the basement of the LEL. A heat-rise sensor is located in the ceiling in Room [redacted] above the assembly tank. Activation of the sensor by a fire will sound the building fire alarm and energize an indicator light on a fire location annunciator panel, which is located at the east main entrance to the Lillibridge Engineering Laboratory Building. In the event of a fire that may cause damage to the fuel plates or foils, a subsequent leak test (swipes) will be performed on all fuel plates and foils.

Calculations of the heat that would be generated by the combustion of all of the wood dividers in the steel storage container for the fuel plates would result in combustion energy about twice what it would take to raise the 41 kg of aluminum [redacted] plates) to their melting temperature. However, there are several reasons why melting could not occur, as follows:

The combustion heat released will also go to the walls of the storage box, with far greater mass and heat capacity than the aluminum plates

It is virtually impossible for enough oxygen to enter the steel storage container to support combustion of the wooden divider material inside, except over a much longer time (days) that would be needed to have fast combustion to raise the temperature to its maximum theoretically possible.

Thus, melting of the aluminum plates is essentially impossible under the current conditions of storage and virtually no combustibles in Room 23. If the plates were stored in the criticality tank, there is nothing combustible in the tank, and hence nothing to raise the plate temperatures. Dispersal of either fission products or SNM material could not occur in the worst-case fire.

Because dispersal of fission products or SNM material cannot occur during the worst-case fire, there is no need for a specific procedure for a fire in the SCA. The evacuation procedure listed in the ISU AGN-201m (Docket #: 50-284) Emergency Plan (also listed in section 13.2 below) is sufficient for this event.

8.6. Inadvertent Criticality

In consideration of the need to assure that criticality cannot ever occur with the materials available for use under the conditions of this license, the following standards have been referenced and relevant compliance established:

ANSI/ANS-8.1-1998, "Nuclear Criticality Safety in Operations with Fissionable Material Outside Reactors." (Though this standard primarily addresses aqueous solutions, it does give some guidelines on solid plates.)
ANSI/ANS-8.3 – 1997 (R2003), Criticality Accident Alarm System
ANSI/ANS 8.23 – 2007, "Nuclear Criticality Accident Emergency Planning and Response."

The SCA is designed to be subcritical by at least 13% ($k_{eff} < 0.87$) under all conditions using ordinary water as a moderator and as the radial and top reflectors. Operational measurements have verified the design calculations. The most reactive configuration is a double plate (two plates together, total thickness of [redacted] inches), in an array with a cell width of [redacted] inches. This configuration, in a geometric arrangement that has closed approximately a circular cross section of diameter 36.4 cm, has a calculated effective multiplication factor of [redacted]. With a thick graphite radial reflector, k=0.95. (Confirmation of the validity of the calculation model, a 19-energy group diffusion theory code, was confirmed experimentally with the approach to critical and an exponential experiment.)

Calculations have been done on a variety of geometric arrangements involving ordinary water and graphite reflectors of various configurations and indicate that criticality is not possible with these materials in any configuration with the [redacted] fuel plates (heavy water with a graphite reflector cannot make a critical assembly using the existing 36-inch diameter and 36-inch-high tank. However, heavy water in a larger tank could make a critical configuration with the [redacted] fuel plates. Criticality would also be possible with the

present geometry tank and beryllium reflector. But neither heavy water nor Be or BeO are permitted in the facility.) Prevention of inadvertent criticality is, therefore, accomplished by restricting or prohibiting the use of superior moderator or reflector materials in the SCA room. Specifically, beryllium, beryllium oxide, and heavy water are not permitted in the SCA room. Additional fissile material is limited to no more than 3 grams.

The use or storage of graphite in the SCA room is restricted. Approximately 4,500 lbs of graphite blocks make up the thermal column beneath the SCA tank. This graphite is stacked in layers within a metal framework and will not be disassembled or otherwise disturbed during operation of the SCA except as to allow for the insertion of suitable neutron source required for the operation of the SCA or fission foils for flux mapping or neutron diffusion experiments. Additional graphite will not be allowed within 4 feet of the SCA or the thermal column, without prior approval of the Reactor Administrator and an analysis of the intended use and its potential effect on the reactivity of the most reactive system. The Reactor Safety Committee must approve the results of the analysis. Any additional graphite shall not be used in conjunction with the operation of the SCA and shall be located away from the licensed material such that there can be only negligible neutronic interactions between the graphite and the licensed material.

In addition to the restrictions placed on the use of the superior moderating and reflecting materials to guard against inadvertent criticality, restrictions shall be in place for the use of other fissile materials in conjunction with the operation of the SCA. Small quantities (not to exceed 3 g total, but not including the Pu-Be neutron source) of fissile nuclides (i.e., U-235 and/or Pu-239) may be used as approved by the Reactor Administrator as neutron monitors (i.e., fission foils or fission detectors under the broad scope license) for flux mapping experiments.

Accordingly, the following administrative control notice will be posted at the entrance to the SCA room:

> "NOTICE: The following materials are <u>NOT</u> to be taken into or stored within the subcritical assembly room [redacted]: beryllium, beryllium oxide, heavy water, or fissile nuclides (i.e., ^{235}U and/or ^{239}Pu) exceeding 3 g of any one isotope or combination of isotopes except for the Pu-Be sources necessary for facility operation. Graphite may be taken into the subcritical assembly room only with the approval of the Reactor Administrator."

A fixed criticality alarm system is installed in Room [redacted], as described in Section 10(a). The alarm fulfills the criticality alarm requirement stated in 10 CFR 70.24(a)(2).

9. Material Control and Accountability [ref. 10 CFR 70.22(b)]

9.1. Material Inventory & Transfer

ISU performs inventory of all special nuclear material associated with the subcritical assembly on an annual basis to comply with the requirements of 10 CFR 74.19(c) because ISU possesses more than [redacted] of U-235 but less than one effective kilogram. Procedure, RS-28, NMMSS Physical Inventory, specifies the methods used to perform the measurement based physical inventory (10 CFR 74.4).

After the physical inventory is completed, ISU prepares and submits the annual material status report on Forms 742 and 742C following Procedure RS-05, NMMSS Reporting, that implements the requirements of 10 CFR 74.13 following the guidance of NUREG/BR-0007 and the Nuclear Materials Management and Safeguards System (NMMSS) User's Guide for material owned by the Department of Energy.

For all transfers and receipts of special nuclear material above applicable thresholds, ISU prepares and submits Form 741 following Procedure RS-05, NMMSS Reporting, that implements the requirements of 10 CFR 74.15 following the guidance of NUREG/BR-0006 and the guidance from the Nuclear Materials Management and Safeguards System (NMMSS) Users Guide for material owned by the Department of Energy.

10. Transportation Security [ref. 10 CFR 70.22(g)(1)]

ISU will not deliver special nuclear material of low strategic significance to a carrier for transport.

11. Emergency Plan [ref. 10 CFR 70.22 (i)(1)(ii)]

The ISU AGN-201m, License No. R-110 and Docket No. 50-284, Emergency Plan is located in ADAMS under accession number ML16285A191 or as updated. This plan contains procedures for response to radiological hazards satisfying 10 CFR 70.22(i)1(ii).

12. Physical Security Plan [ref. 10 CFR 70.22(k)]

The ISU AGN-201m, License No. R-110 and Docket No. 50-284, Physical Security Plan is located in ADMAS under accession number ML191150A123 or as updated. The Physical Security Plan details how ISU meets the requirements of 10 CFR 73.67(f). The ISU AGN-201m Emergency Plan contains the emergency procedures including response to thefts of special nuclear material, satisfying 10 CFR 73.67(f)(4).

13. Criticality Accident Requirements [ref. 10 CFR 70.24]

13.1. Criticality alarm

The installed criticality alarm is discussed in detail in sections 7.3 "Measuring and monitoring instruments" and 7.38.6 "Inadvertent Criticality".

13.2. Emergency evacuation procedure

The procedures given below will be carried out under the direction of the person responsible for the assembly at the time the emergency occurs. Detailed emergency procedures are provided in the approved facility Emergency Plan referenced in section 11 above.

All power to the pump and solenoid drain valve will be shut off by placing the drain valve and pump power switch in the OFF position. (This step backs up the function performed when the criticality alarm is activated.)

The portable ion chamber survey meter will be taken from Room [redacted] by the evacuating personnel.

Once all personnel are out of Room [redacted], the door will be closed and a radiation dose rate survey will be performed in all areas adjacent to Room [redacted]. If radiation levels exceed 10 mrem/hr outside or Room [redacted], the building fire alarm will be activated to evacuate the entire building. Pull stations for activating the fire alarm are located in the main corridors near the stairs as shown in the basement building floor plan in Figure [redacted]. Exits and access routes to and from the basement are shown on the basement building floor plan and in the first-floor plan (Figure [redacted]).

Building ventilation will be secured by pushing the "Penthouse Power Emergency Trip" switch located on the wall facing Room 15 about 6 feet inside the door entrance #14 to the Nuclear Engineering Laboratory complex.

The Reactor Administrator, the Radiation Safety Officer, and the Reactor Supervisor or their designated alternates are all on an emergency call list and will be notified of the emergency. Building reentry will be directed by the Reactor Administrator and/or the Reactor Supervisor in consultation with the Radiation Safety Officer (or their alternates).

Emergency equipment and communication and alarm systems will be tested annually. Emergency procedures will be reviewed with permanent staff and personnel who work with the SNM. Periodic review of these procedures will be accomplished by annual instruction and drills.

14. Financial Assurance for Decommissioning [ref. 10 CFR 70.25]

10 CFR 70.25 requires financial assurance for uranium enrichment facilities and facilities that handle dispersible special nuclear material in quantities greater than 10^5 times the values in 10 CFR 30 Appendix B. All of the material that will be used in the ISU sub-critical assembly is sealed (fuel plates, fission foils, fission counters, and sealed sources). Therefore, the requirement to provide financial assurance does not apply.

The special nuclear material in the sub-critical assembly, fuel plates, fission foils, and fission counter is owned by the Department of Energy. At the time of decommissioning, the materials will be returned to the DOE in appropriated fissile shipping containers. At that time, a physical security plan for shipment of SNM of low strategic significance will be prepared in accordance the 10 CFR 70.22 (g) (1) and will be submitted to the NRC in an amendment request. Decommissioning is not expected in this 10-year renewal period.

15. Environmental Protection

15.1. Air Effluents

ISU complies with the NRC constraint on air emissions specified in Regulatory Guide 4.20 to demonstrate that no member of the public receives a dose equivalent from air emissions greater than 10 mrem. Specifically, ISU follows the guidance of EPA-520/1-89-002, A Guide for Determining Compliance with the Clean Air Act Standards for Radionuclide Emissions from NRC-licensed and non-DOE Federal Facilities to model air emissions using the COMPLY code. All of the materials used in the sub-critical assembly are sealed sources (fuel plates, fission foils, and neutron sources) and are not included

in the emission source term based on the EPA source term guidance. Therefore, the air emissions from the sub-critical assembly are zero.

15.2. Liquid Effluents

There are no liquid effluents from the sub-critical assembly. If the water used in the sub-critical assembly becomes activated or contaminated it will be managed as radioactive waste and discharged to the sanitary sewer system or disposed by transfer to a licensed waste broker as described in the radioactive waste section 8.3

15.3. Radioactive Waste

Radioactive waste is discussed in Section 8.3

15.4. Impact from Accidents

10 CFR 70 Subpart H does not apply to the sub-critical assembly because it does not involve enriched uranium processing, fabrication of uranium fuel or fuel assemblies, uranium enrichment, enriched uranium hexafluoride conversion, plutonium processing, fabrication of mixed-oxide fuel or fuel assemblies, or scrap recovery of special nuclear material. Therefore, there is no evaluation of accident impacts on members of the general public.

16. Chemical Safety

Chemical hazards associated with operation of the sub-critical assembly will be evaluated by appropriate personnel in the Environment Safety and Health (EHS) Department in accordance with the ISU Chemical Hygiene Plan. The reactor administrator will evaluate all new and revised procedures to determine if they involve chemical hazards. If so, the reactor administrator will send the procedure to the Director of the EHS department for chemical safety review. Comments provided by the EHS department will be sent to the reactor safety committee for a complete record of the review and will then be incorporated in the applicable procedure.

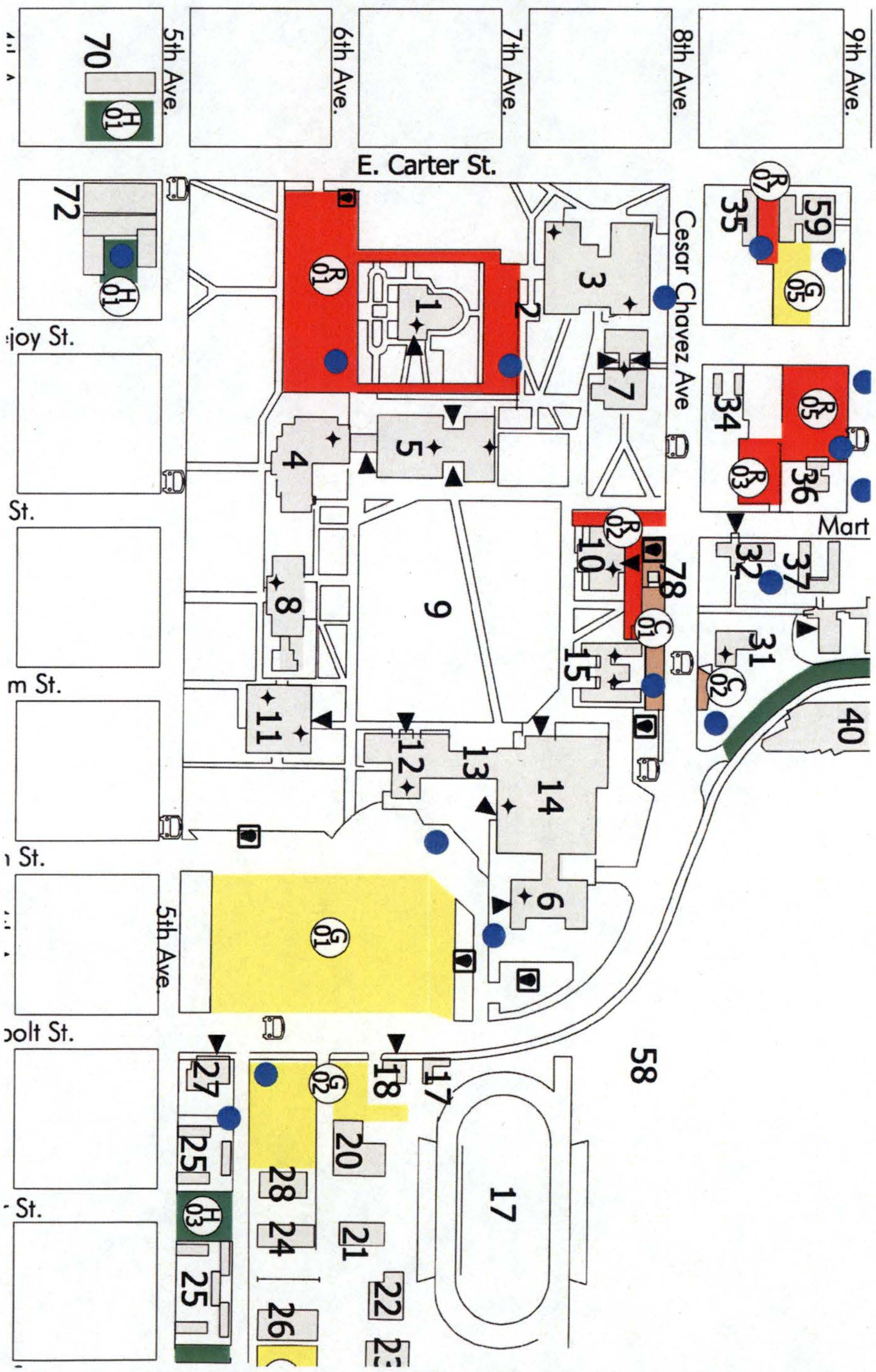


Figure 1: Campus Map - LEL is building #7 and Campus Security is #27

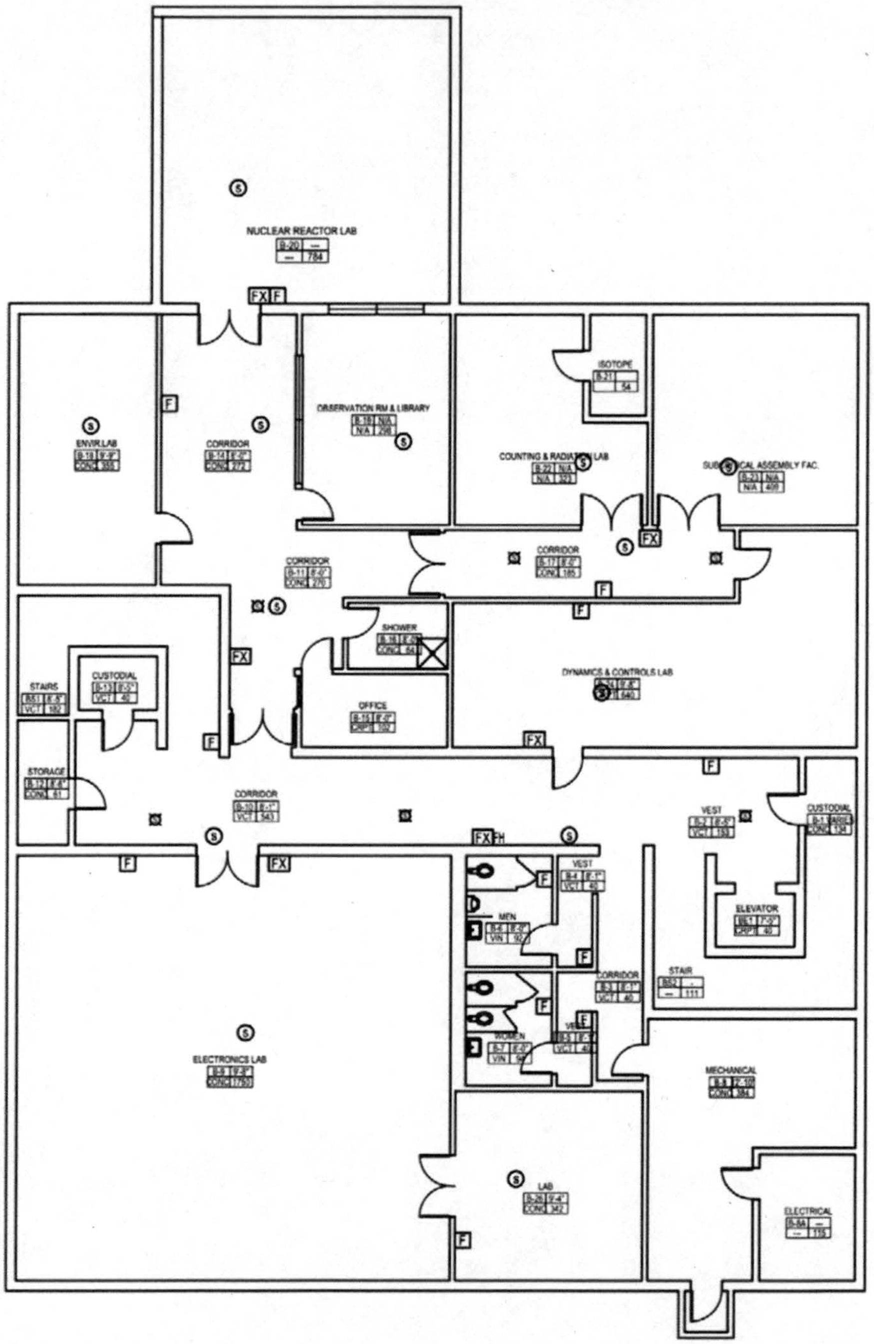


Figure 2: Basement of Lillibridge Engineering Building

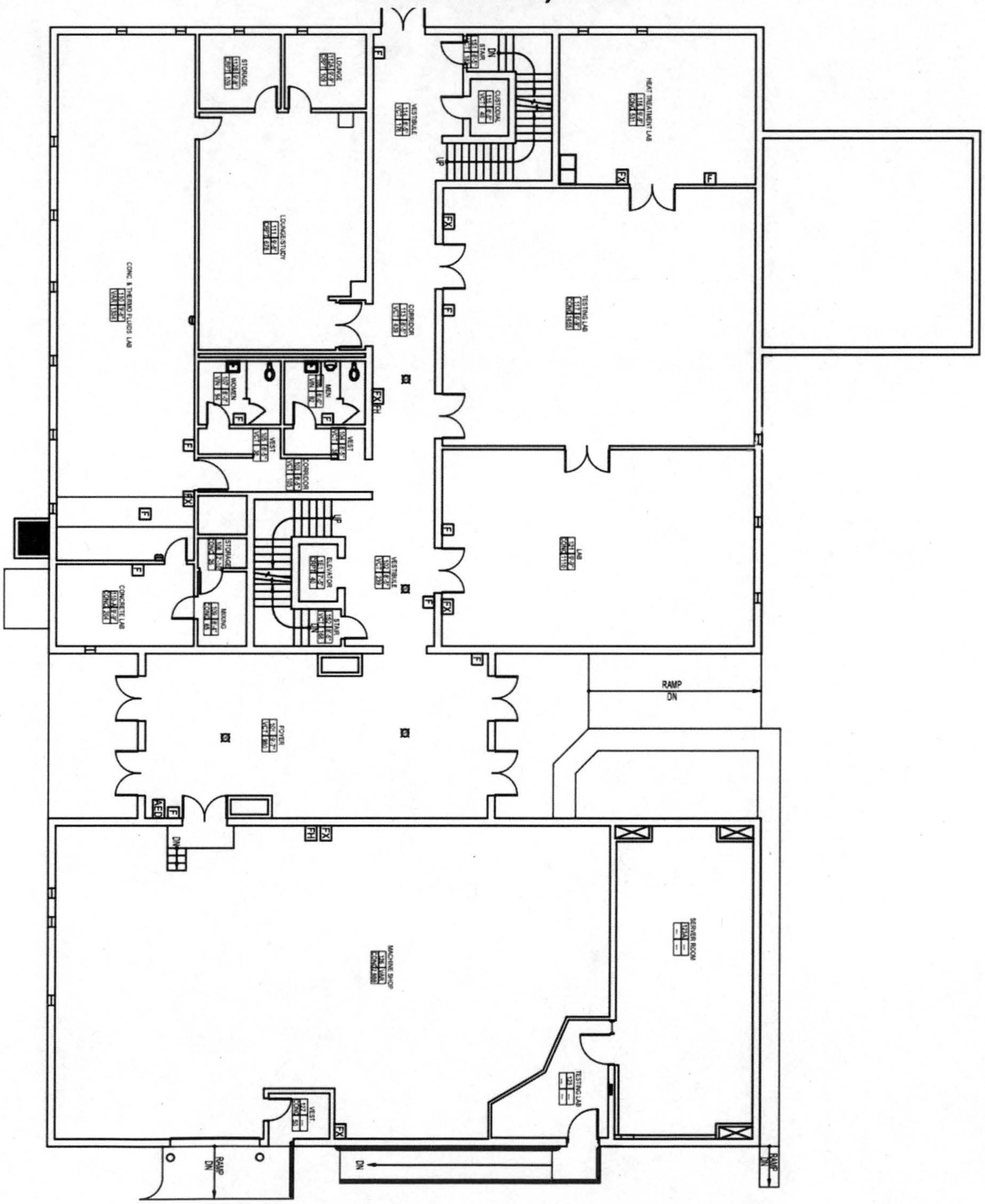


Figure 3: First Floor of Lillibridge Engineering Building

Attachment I
Idaho State University Roster of Officials
for Materials License SNM-1373, Docket No. 1374

17. Attachment I: Idaho State University Roster of Officials

President of the University
Kevin Satterlee, J.D.
264 Administration Building, Mail Stop 8310
Idaho State University
Pocatello, ID 83209-8310
Tel: (208) 282-3440
Email: kevinsatterlee@isu.edu

Vice President for Research
Donna L. Lybecker, Ph.D.
106 Administration Building, Mail Stop 8130
Idaho State University
Pocatello, ID 83209-8130
Tel: (208) 282-2592
Email: donnalybecker@isu.edu

Chair of the Department of Nuclear Engineering
Chad Pope, Ph.D.
235 Lillibridge Engineering Building, Mail Stop 8060
Idaho State University
Pocatello, ID 83209-8060
Tel: (208) 282-2875
chadpope@isu.edu

Chairperson of the Reactor Safety Committee
Kermit Bunde, P.E.
US Department of Energy, Idaho Operations Office
1995 Fremont Street
Idaho Falls, ID 83415
Tel: 208-526-5188
Email: bundeka@id.doe.gov

Radiation Safety Officer
John Longley, CHP
Idaho Accelerator Center
Idaho State University
Pocatello, ID 83209-8263

Attachment I
Idaho State University Roster of Officials
for Materials License SNM-1373, Docket No. 1374

Tel: (208) 282-5652
Email: johnlongley@isu.edu

Reactor Administrator and Reactor Supervisor

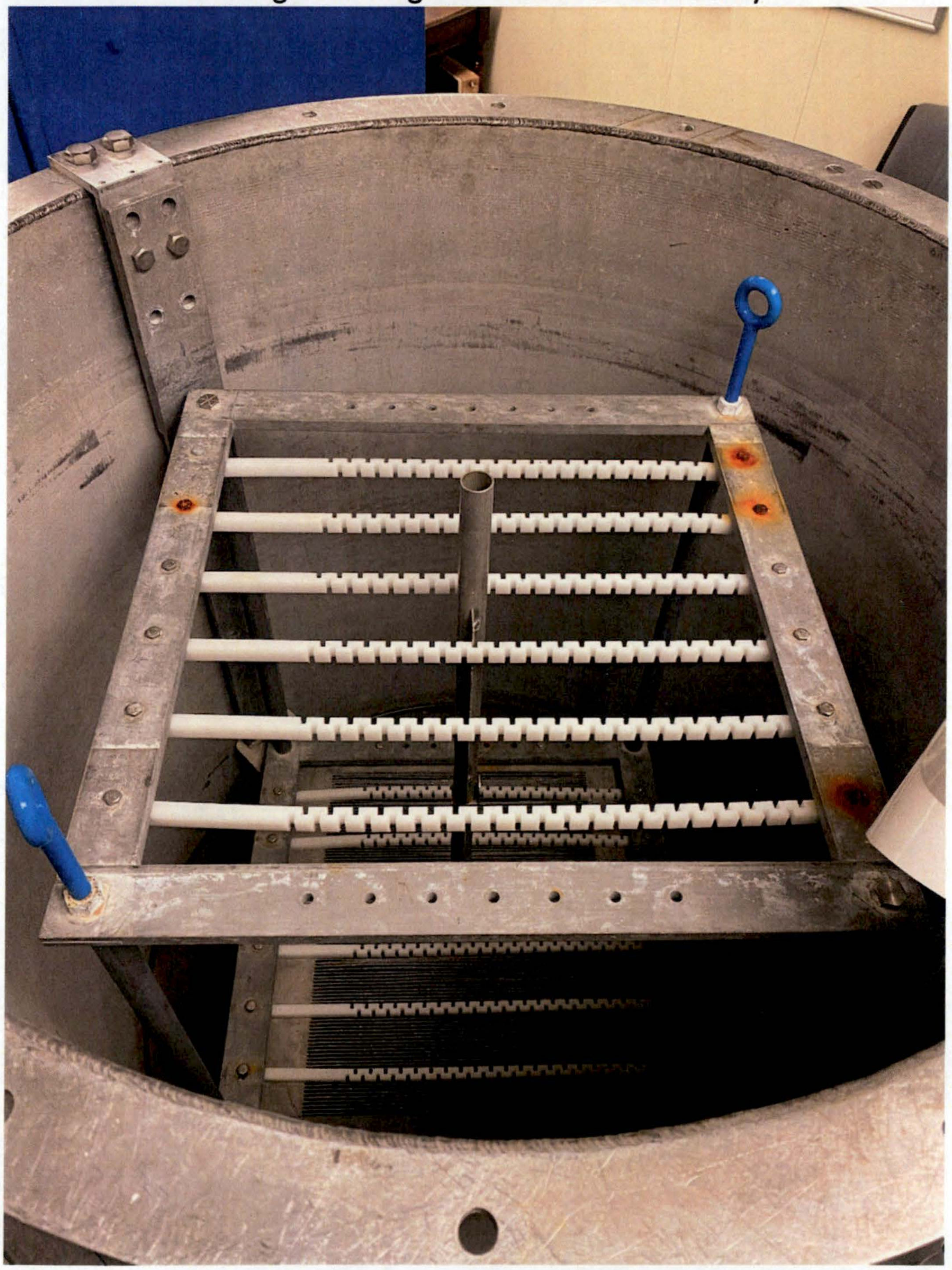
Mary Lou Dunzik-Gougar, Ph.D.
Center for Advanced Energy Studies
Idaho State University
Pocatello, ID 83209-8060
Cell: (208) 569-9915
Email: mldg@isu.edu

Reactor Supervisor in Training

Jonathan Scott
Lillibridge Engineering Laboratory
Mail Stop 8060
Idaho State University
Pocatello, ID 83209-8060
Tel: (208) 282-1491
Cell: (573) 466-2792
Email: jonathanscott@isu.edu

Attachment II
Drawings and Images of the Subcritical Facility
for Materials License SNM-1373, Docket No. 1374

18.Attachment II: Drawings and Images of the Subcritical Facility



Attachment II
Drawings and Images of the Subcritical Facility for Materials License SNM-1373, Docket No. 1374

[redacted]

Figure II-2: Details of the Fuel Plate Structure

Attachment II
Drawings and Images of the Subcritical Facility for Materials License SNM-1373, Docket No. 1374

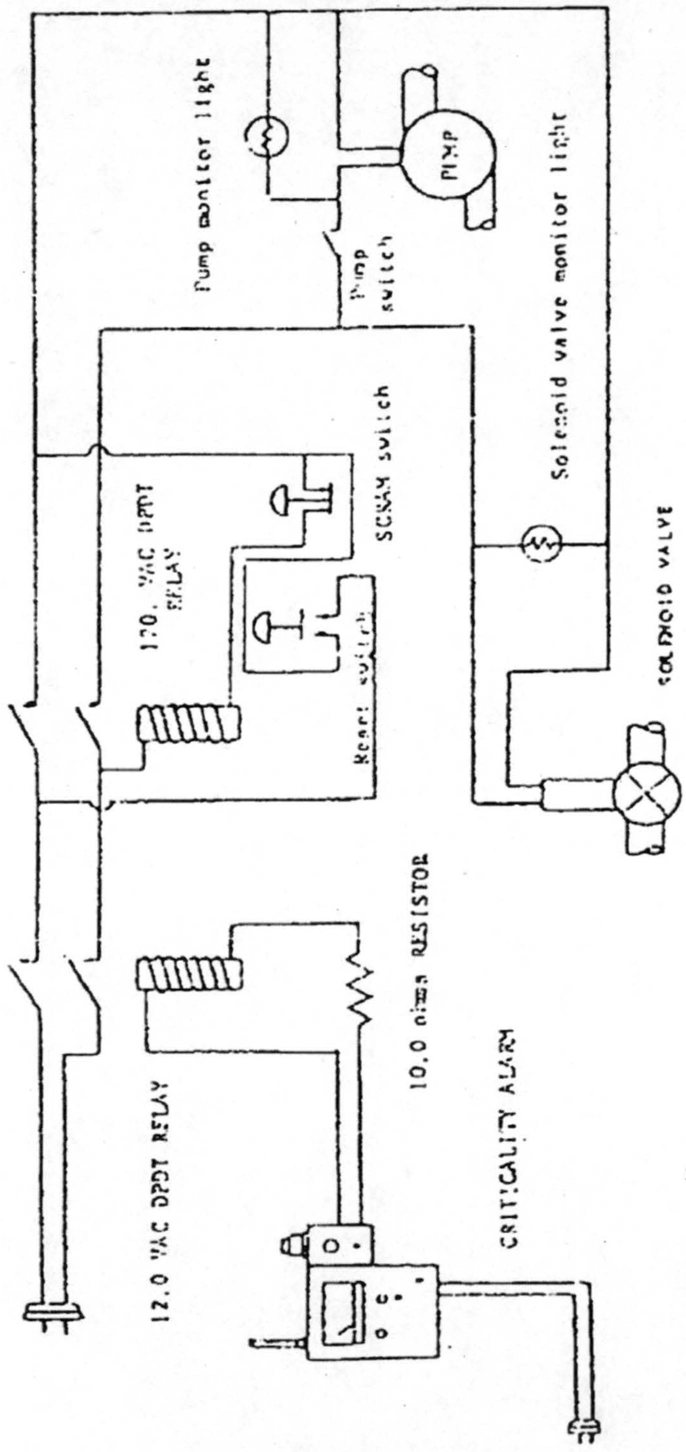


Figure II-3: Wiring Diagram for Subcritical Assembly

Attachment II
Drawings and Images of the Subcritical Facility
for Materials License SNM-1373, Docket No. 1374

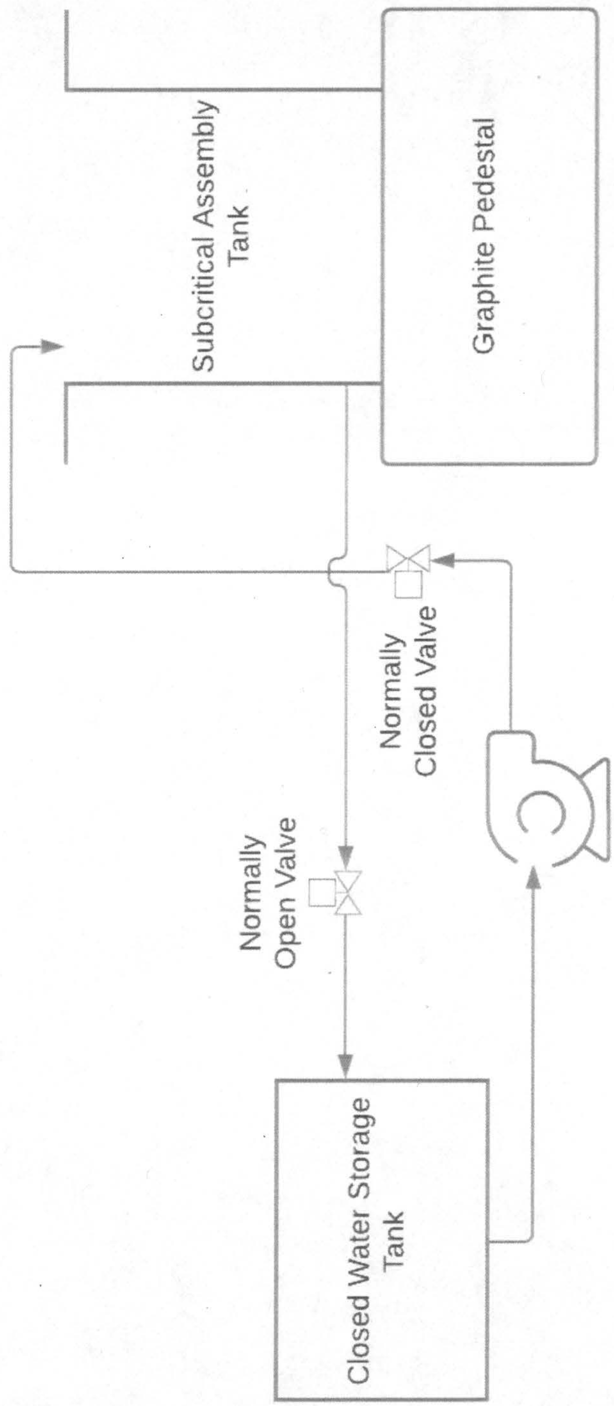


Figure II-4: Piping Diagram for Subcritical Assembly

Attachment III
Specifications of Uranium-Aluminum Fuel Plates, Uranium-Aluminum Foils, and Fission Counter

19. Attachment III: Specifications of Uranium-Aluminum Fuel Plates, Uranium-Aluminum Foils, and Fission Counter

FBE NBL
ZTM Rutgers
1510.5

SPECIAL NUCLEAR MATERIAL IN SUB-CRITICAL ASSEMBLY

(a) Uranium-Aluminum fuel plates:

The fuel plates were fabricated in 1960 by M & C Nuclear, Inc., for Rutgers University, New Brunswick, New Jersey. Each plate consists of a Uranium-Aluminum fuel zone completely enclosed by an aluminum clad. The plates are subjected to a wipe test semiannually and no alpha emitting material has ever been found on the outside of the plates. Detailed description of the plates are:

Total number of plates:
Total mass of uranium
Enrichment of U-235 isotope
Total U-235 content (all plates)
U-235 loading per plate
Overall plate dimensions
Dimensions of U bearing portion
Clad thickness

[redacted]

(b) Uranium-Aluminum foils:

The Uranium-Aluminum foils each consist of a very small amount of uranium, highly enriched in the uranium-235 isotope, deposited in the center of an aluminum disk. A second aluminum disk is then placed on top and the outside contact area of the disks not containing uranium is sealed. Thus, the foils are each a sealed source containing a small amount of uranium-235. The foils are subjected to a wipe test semiannually and no alpha emitting material has ever been found on the outside of the disks. Detailed description of the foils are:

Number of foils
Total uranium mass
Enrichment of U-235 isotope
Total U-235 mass
U-235 mass per foil
Foil diameter
Foil thickness
Clad thickness

[redacted]

Attachment III

Specifications of Uranium-Aluminum Fuel Plates, Uranium-Aluminum Foils, and Fission Counter

(c) Fission counter:

The fission counter, manufactured by Westinghouse, model [redacted] is designed to be used as a flux mapping probe. The active length of the counter is only 1.0" with an active diameter of 0.20". The counter, which contains [redacted] milligrams of uranium-235 is sealed into one end of a stainless steel tube [redacted] long and [redacted] in diameter. A BNC connector is attached to the other end of this tube for electrical connection. A detailed description of the counter is:

Active length of counter
Active diameter
Enrichment of U-235 isotope
Uranium-235 mass
Case material
Operating voltage

[redacted]

Dave Lewinski

Attachment IV

Qualifications of University Personnel Responsible for Materials License SNM-1373, Docket No. 1374 (also for R-110 Reactor License)

20. Attachment IV: Qualifications of University Personnel

A) Responsible University Officer, currently the Vice President for Research

- PhD or equivalent education
- Senior Manager at ISU
- At least 5 years of supervisory/administrative experience

B) Chair of the Department of Nuclear Engineering

- PhD or equivalent education
- At least 2 years of experience related to nuclear reactor operations (need not have power reactor experience)

C) Chairperson of Reactor Safety Committee

- BS or higher in an engineering field or physical science field
- At least 5 years of experience related to nuclear reactor operations (need not have power reactor experience)
- A professional engineering license is desirable but not essential

D) Reactor Administrator

- MS or PhD in an engineering or physical science field
- At least 2 years of experience related to nuclear reactor operations (need not have power reactor experience)
- A professional engineering license is desirable but not essential
- Certification as a Health Physicist is desirable but not essential
- Note: it is not necessary for the Reactor Administrator or the Assistant Reactor Administrator to have or retain certification as either a Reactor Operator or Senior Reactor Operator

Attachment IV

Qualifications of University Personnel Responsible for Materials License SNM-1373, Docket No. 1374 (also for R-110 Reactor License)

E) Reactor Supervisor

- BS in an engineering or physical science field
- At least 2 years of experience related to nuclear reactor operations (need not have power reactor experience)
- Pass the requirements, or equivalent, for having a Reactor Operator License, and obtain a Senior Reactor Operator License within one year of qualifying for the Reactor Operator License
- Must maintain certification as a Senior Reactor Operator

F) Radiation Safety Officer

One of the following are the minimum requirements for the Radiation Safety Officer

- BS (or higher degree) in health physics, nuclear engineering, or closely related field, and five years of experience related to health physics/radiation protection
- Certification by the American Academy of Health Physics or nominally equivalent relevant certification