Application for License Renewal
Materials License No. SNM-1373
July 11, 2021

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

Table of Contents

Table of Figures

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

Name: Idaho State University
Address: 921 South 8th Ave.
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

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.

2) 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] g of U-235 rounded up to the nearest gram as was specified in the previous license: [redacted] g of U-235 are contained in [redacted] uranium-aluminum fuel plates and the remaining U-235 is [redacted] g contained in a fission counter and [redacted] g in [redacted] uranium-aluminum foils.

a) Principal Location of Use

The SNM will be used primarily in Room [redacted] in the basement of the Lillibridge Engineering Laboratory (LEL) building. The material will be stored in a locked storage container in Room [redacted]. A map of the ISU campus showing the location of the LEL building is shown in Figure 1, as Building #7. The LEL basement floor plan is shown in Figure 2. Room [redacted] is a 20-feet by 20-feet square with a 12-foot ceiling. The floor is a 4-inch-thick reinforced concrete slab. The floor will safely accommodate the weight of the entire SCA. Room [redacted] is a controlled access area (CAA). Only ISU personnel with Trustworthy & Reliability (T&R) status, in accordance with Administrative Procedure 2: T&R, have authorized unescorted access to CAAs in the Nuclear Engineering Laboratory.

The fuel plates will primarily be used in the LEL building where they will be loaded in various lattice arrangements in a water-filled tank to produce a subcritical assembly (SCA). Attachment (II) is a more detailed description of the SCA. The fuel plates may be used singly for a quasi-homogeneous assembly or in groups of two or more to produce a more heterogeneous configuration. The uranium-aluminum foils will be used as neutron monitors in some experiments.

The materials are used primarily for instructional purposes in senior and graduate-level laboratory courses. In addition, research programs utilizing the materials in the subcritical assembly will also be encouraged. No experiments or activity involving the use of the SNM will be performed without the prior approval of the Reactor Administrator or Reactor Supervisor.

Some of the experiments to be carried out with the subcritical assembly are:

1) Approach to critical
2) Flux distribution measurements
3) Exponential pile measurements
4) Fermi age determination
5) Determination of optimal cell dimensions of a heterogeneous subcritical assembly
6) Effect of fuel-plate thickness on multiplication factor

Additional experiments will be reviewed by the Reactor Safety Committee prior to execution.

b) Alternate Locations of Use

Small amounts of the SNM, consisting of up to [redacted] of the U-Al foils and/or up to ten(10) of the fuel plates, may be transported to other locations in the reactor lab for temporary one-day use. These alternate locations are:

1) The Nuclear Engineering Counting Lab Room 22
2) The AGN-201 Nuclear Reactor Room 20. (Figure 2)

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 include the Reactor Administrator, Reactor Supervisor, Nuclear Engineering Department Chair, or a trained SCA operator, qualified in accordance with Administrative Procedure 4: Qualification Knowledge Requirements Section 3.2.)

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.

3) 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.

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

a) Uranium-aluminum fuel plates

The fuel plates were fabricated in 1960 by M&C Nuclear, Inc., for Rutgers University, New Brunswick, New Jersey. The manufacturer's specifications for the plates are as follows:

Total number of plates	[redacted]
Total mass of uranium	[redacted] g
Enrichment of U-235	[redacted]
Total U-235 content	[redacted] g
U-235 loading per plate	[redacted] g
Overall dimensions of plate	([redacted] $\pm$ [redacted] in) x ([redacted] $\pm$ [redacted] in) x ([redacted] $\pm$ [redacted] in)
Dimensions of uranium bearing portion of the plate	([redacted] in x [redacted] in x [redacted] in)
Cladding thickness	[redacted] in

b) Fission counter and uranium-aluminum foils

i. Fission counter

Total uranium mass	[redacted] g
U-235 enrichment	[redacted]%

ii. Uranium-aluminum foils

Total number of foils	[redacted]
Total uranium mass	[redacted] g ([redacted] grams of U-235 per foil)
U-235 enrichment	[redacted]%

iii. 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.

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

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

Responsibility for the supervision and operation of licensed activities will reside with the Reactor Administrator, Reactor Supervisor, and the ISU Radiation Safety Officer.

Biographical data listing qualifications for those members of the ISU faculty who have responsibility for the supervision and operation of the uranium are included in Attachment (I).

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

Attachment (II) is a description of the Subcritical Assembly, including figures.

a) Handling procedures

i. Fuel plates

Disposable gloves will be used by personnel while handling the fuel plates.

ii. Uranium-aluminum foils

Tongs or disposable gloves will be used by personnel while handling the foils.

b) Working area

See section 3 above: “The Place and Plan for Carrying Out the Activity.”

c) 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)

All radiation detection instruments used in connection with this license shall be calibrated by the ISU Radiation Safety Office 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. The types of instruments available to personnel are equivalent to the instruments described above.

A gamma radiation area monitor criticality detector shall be mounted near to (within 6 feet) the SCA tank with a readout visible to the operator.

d) Waste disposal

There will be very little waste contaminated by radioactive materials resulting from the handling, storage, and use of materials under this license. Contaminated material will be controlled and disposed by ISU Radiation Safety Office personnel in accordance with the Radiation Safety Manual.

e) Storage facilities and security measures

(This information is provided in Attachment (III).)

f) 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 drain pipe 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 (≥ 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).

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

a) Radiation Hazard

Reactor personnel (reactor operators, the reactor administrator, and the reactor supervisor) wear Landauer Ta dosimeters that measure beta, gamma, and neutron dose. 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. Visitors and laboratory students are monitored with Pen dosimeters.

Radiation levels (gamma and neutron) from the subcritical assembly are monitored as specified in the Subcritical Assembly Procedure of the Idaho State University Reactor 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 exposure rate of 10 mR/hr, the system will automatically drain the water from the system.

b) 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.

c) Inadvertent Criticality

The SCA is designed to be subcritical by at least [redacted]% (k_{eff} < [redacted]) under all conditions using ordinary water as a moderator and as the radial and top reflectors. Operational measurements have verified the design calculations. Criticality, however, might be possible by a deliberate and unauthorized use of superior moderator or reflector materials with the licensed material arranged in an optimal geometric configuration. Prevention of inadvertent criticality is accomplished by 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. 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 sourced 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.

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 [redacted] 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 [redacted] g of any one isotope or combination of

isotopes except for the Pu-Be neutron 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).

d) Leakage testing and surveys

Ten percent (10%) of the fuel plates will be leak tested using standard swipes for alpha contamination following each experiment and at normal inventory periods. Ten percent (10%) of the uranium-aluminum foils will be leak tested in conjunction with the fuel plates following use or when performing the inventory unless the foils are stored in a sealed container with a tamper indicating device. For the purposes of satisfying the requirements in this section, it will be assumed that a leak test was performed satisfactorily if it was performed within a week of completion of the experiments.

Water samples will be analyzed for gross activity following each experiment to detect possible damage to, or defects in, the fuel plates. Water samples will be analyzed by the Radiation Safety Office using a liquid scintillation counter.

A general area and contamination survey will be performed in conjunction with the leakage testing after each experiment. In addition, a bi-annual general contamination survey and radiation survey will be performed in Room [redacted], under the direction of the Radiation Safety Office in accordance with the Radiation Safety Manual.

e) Fuel integrity

The fuel plates have been used for laboratory experiments at the SCA in Rom [redacted] for four decades. The careful handling of the plates during this period has resulted in no detectable leaking of fission products, based on swipes following the experiments, and analysis of the tank water.

8) Material Control and Accountability

a) Inventory procedures

Inventory of the material will be performed twice each year in accordance with Radiation Safety Office procedures and the Radiation Safety Manual. An approved emergency plan establishes procedures to be followed in the event of loss or theft of special nuclear material.

b) 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 all plans and 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, at least one with current T&R status in Room [redacted] whenever operations involving special nuclear material in the subcritical assembly are in progress. 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 grated 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.

In accordance with the Radiation Safety Manual, reactor workers (administrator, supervisor, faculty, operators, observers, etc.) will complete the ISU radiation safety training provided by the Radiation Safety Department prior to handling fuel plates or other radioactive materials. Laboratory students and visitors will be provided awareness training by the authorized user or designee.

Statement of qualifications for personnel responsible for the use of the special nuclear materials under this license are attached in Attachment (I).

9) Additional requirements [ref. 10 CFR 70.24]

a) Criticality alarm

A gamma radiation area monitor criticality alarm is installed on the wall less than six feet away from the assembly tank. The criticality alarm system meets t
he radiation level criteria stated in 10 CFR 70.24(a)(2).

b) 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.

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.

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 survey will be performed in all areas adjacent to Room [redacted]. If radiation levels exceed 10 mrem/hr outside of 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 2. Exits and access routes to and from the basement are shown on the basement building floor plan and in the first floor plan (Figure 3).

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.

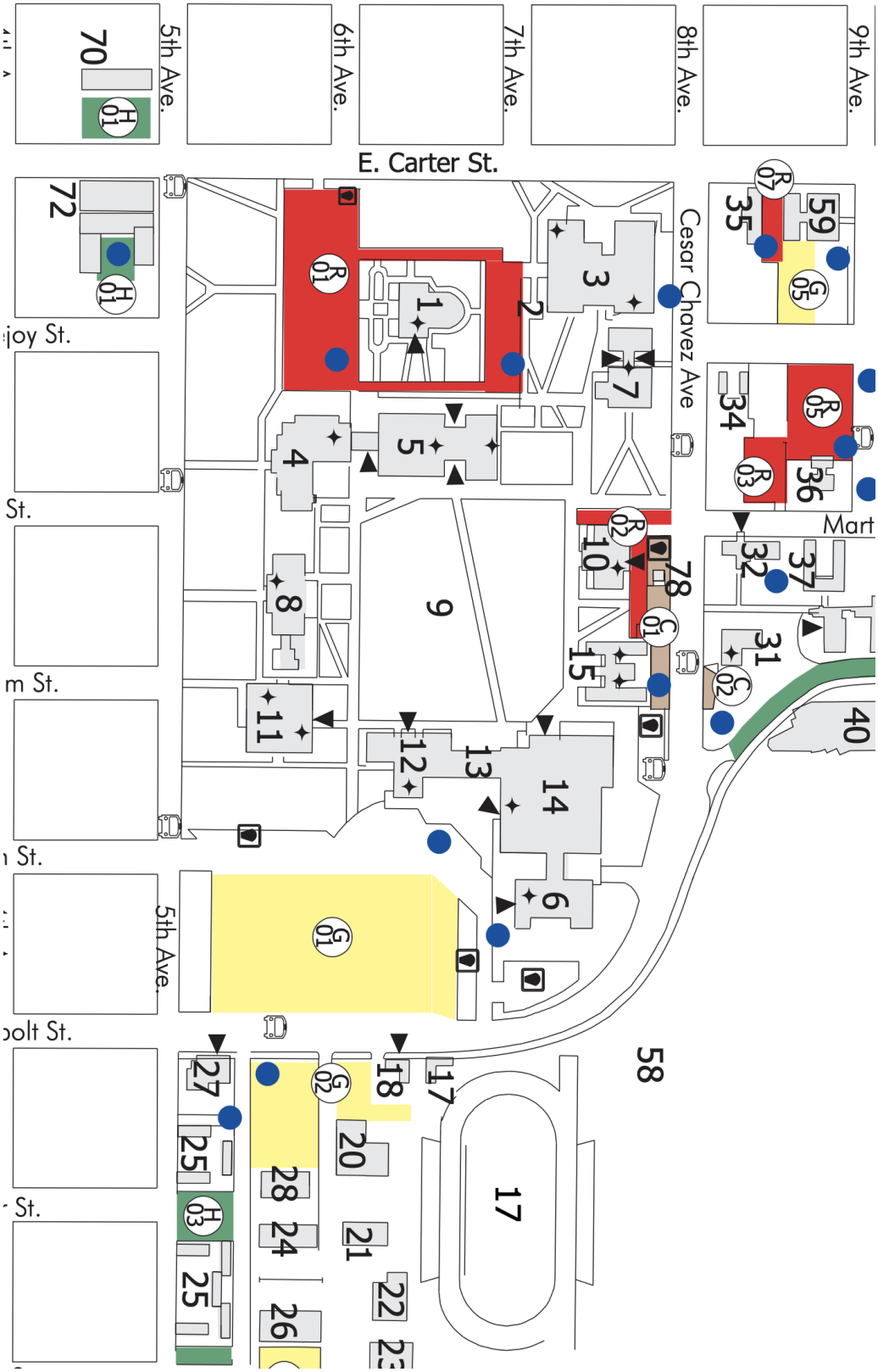

Figure 1: Campus Map - LEL is building #7 and Campus Security is #27

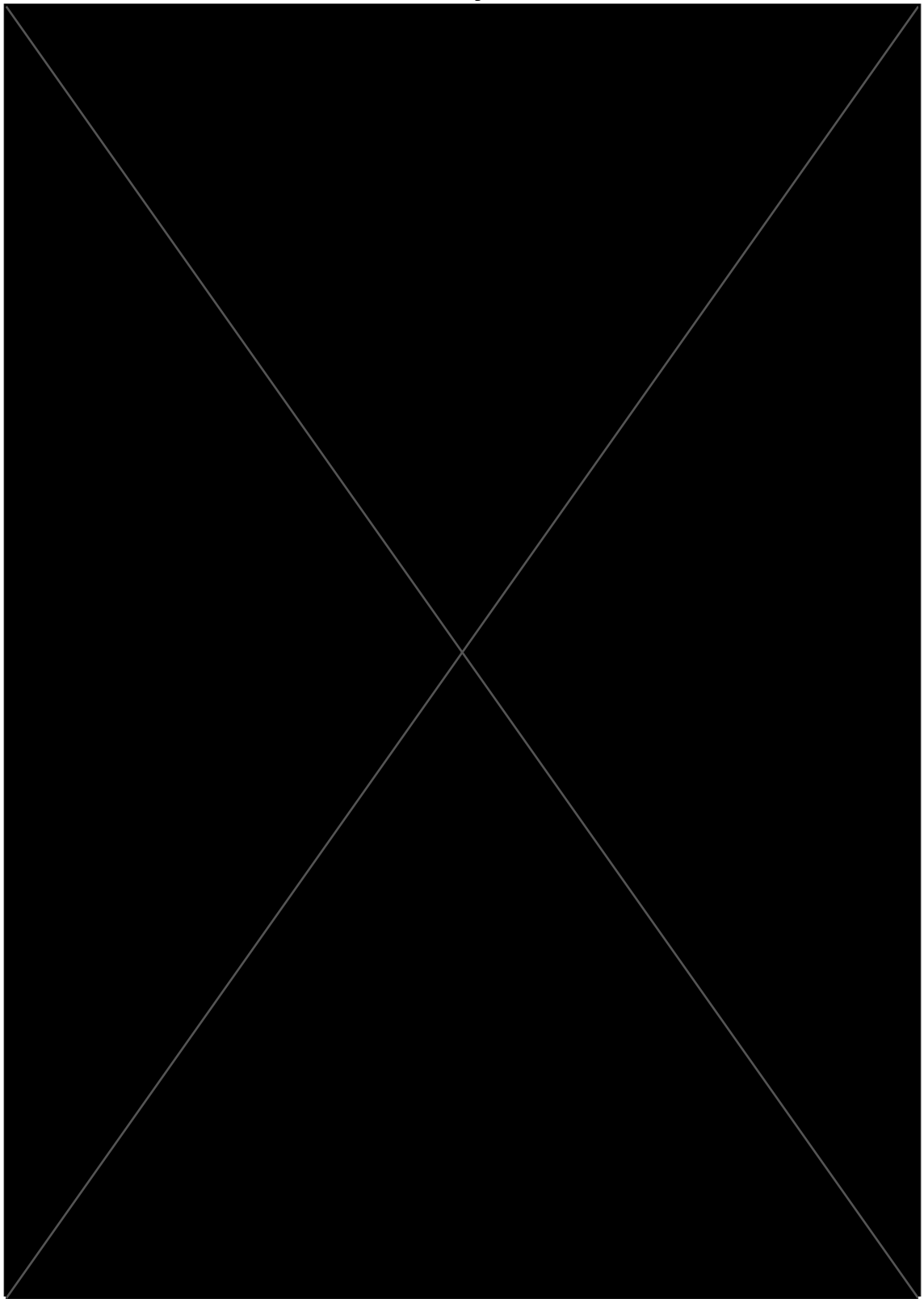

Figure 2: Basement of Lillibridge Engineering Building

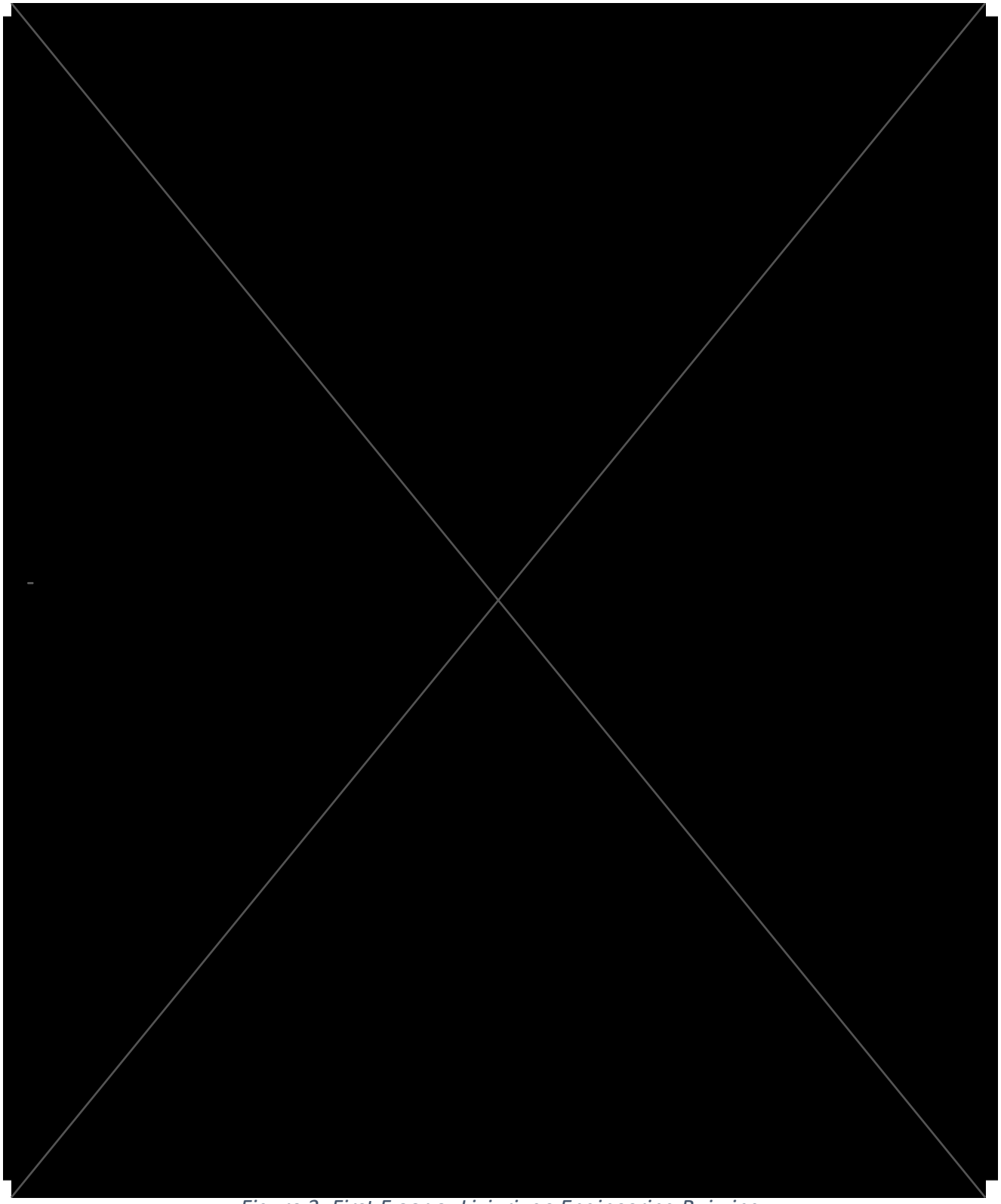

Figure 3: First F oor o Li i ri ge Engineering Bui ing

Attachment I
Description of the Subcritical Facility
for Materials License SNM-1373, Docket No. 1374

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Attachment I
Description of the Subcritical Facility
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Attachment II
Description of the Subcritical Facility
for Materials License SNM-1373 Docket No. 1374

[redacted]

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[redacted]

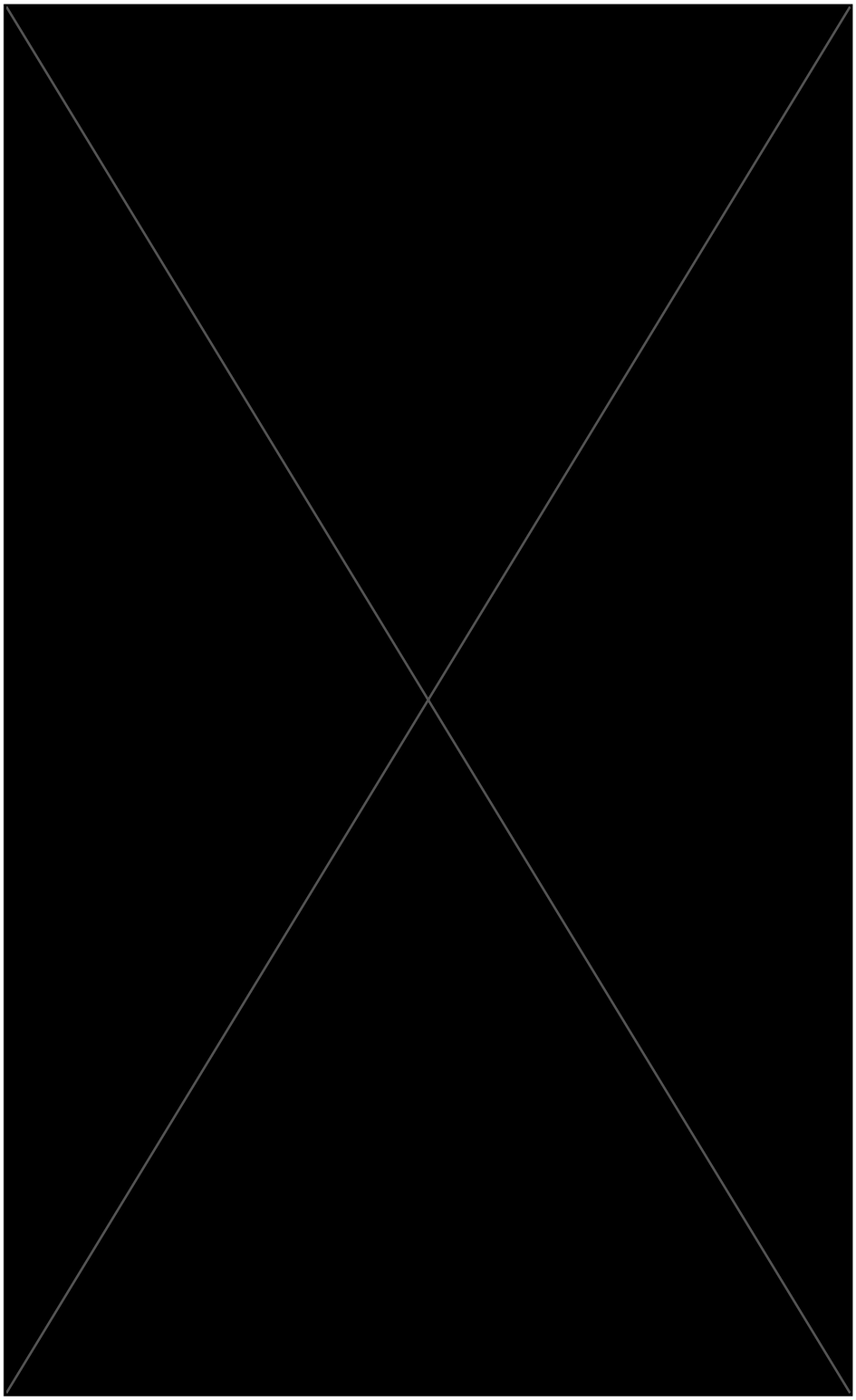

Figure II-2: Details of the Fuel Plate Structure

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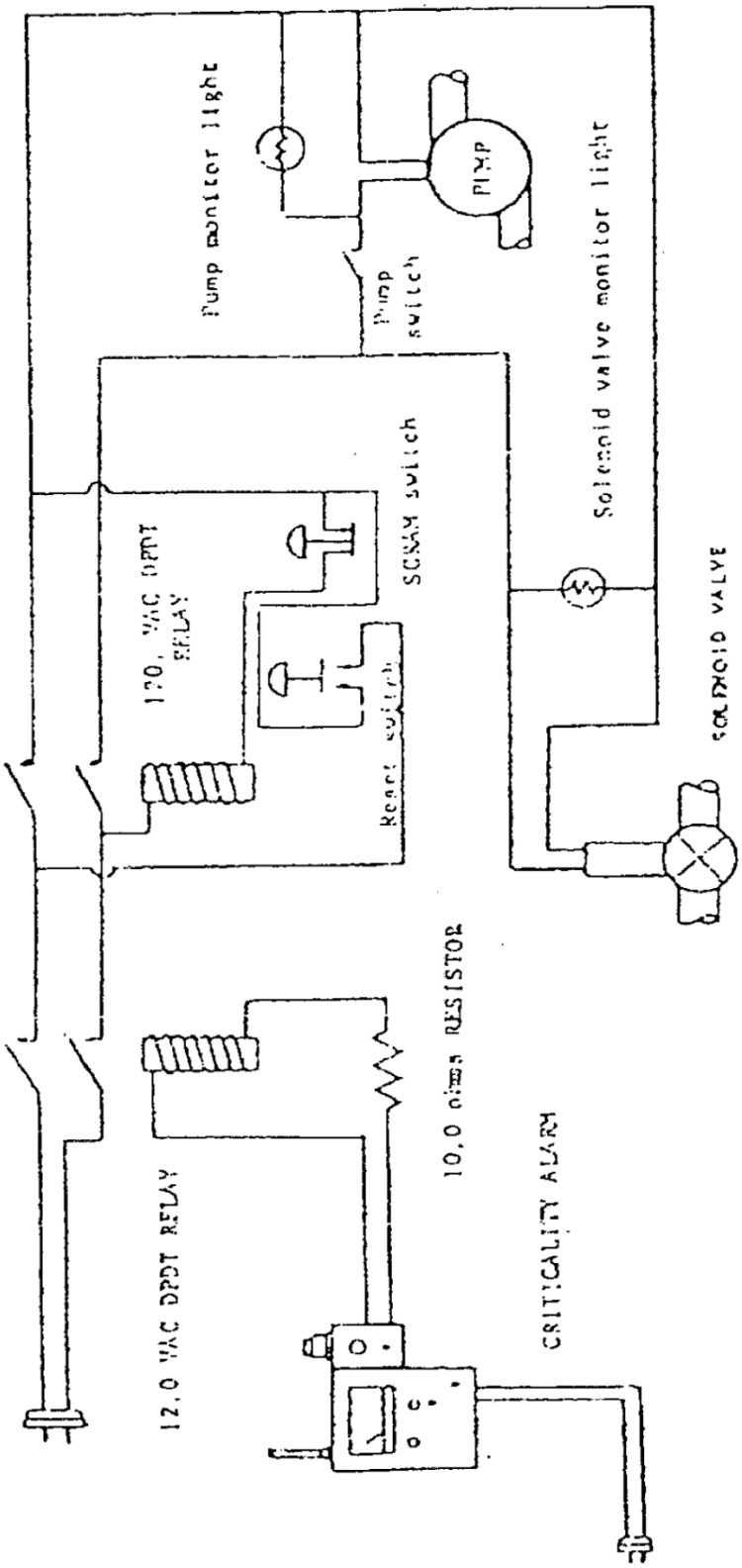

Figure II-3: Wiring Diagram for Subcritical Assembly

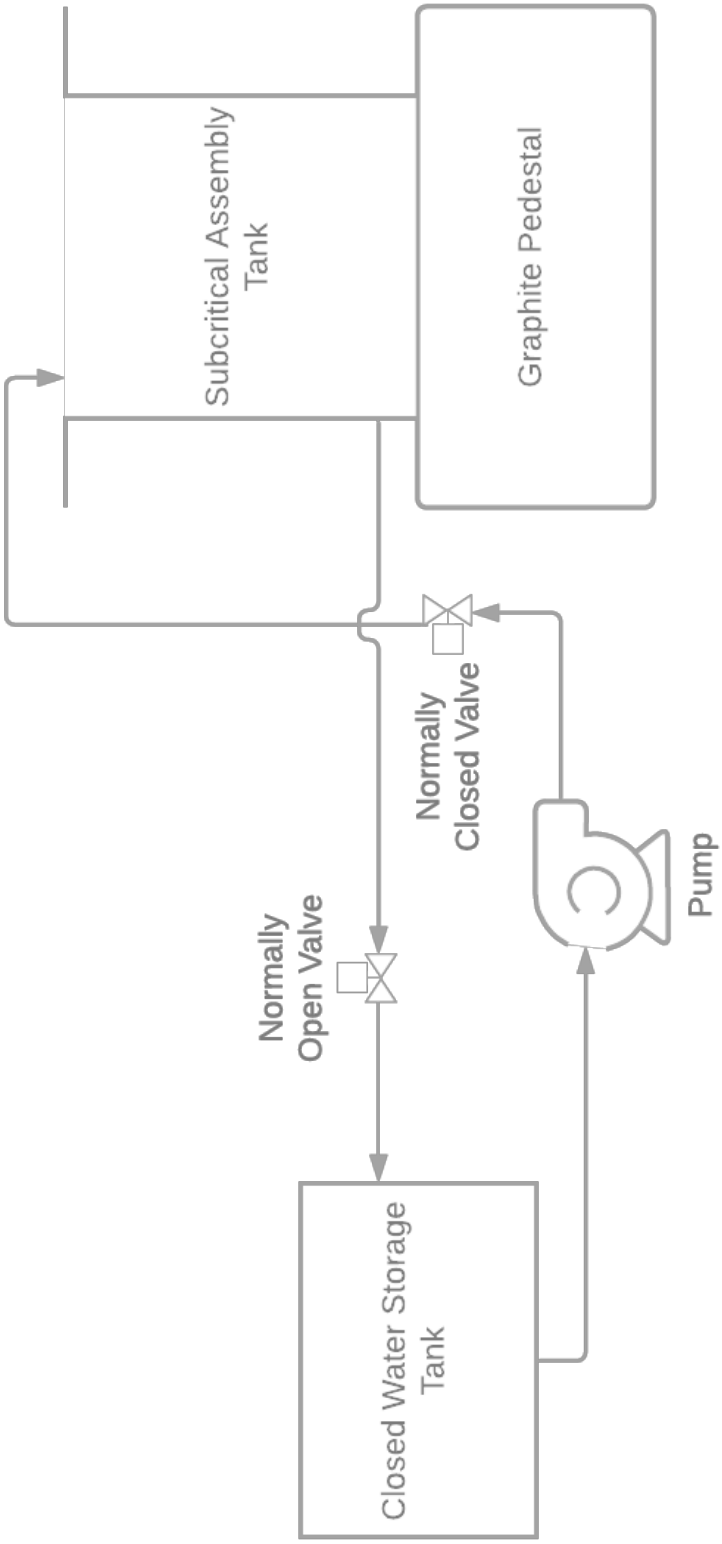

Figure II-4: Piping Diagram for Subcritical Assembly

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

FBE NBL
ZTM Rutgers
K510.5

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 [redacted] with an active diameter of [redacted]. The counter, which contains [redacted] milligrams of uranium-235 is sealed into one end of a stainless steel tube 40" 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