Department of Physics
Bates College
Lewiston, ME 04240
February 26, 1987

U. S. Nuclear Regulatory Commission
Nuclear Material Section B
631 Park Avenue
King of Prussia, PA 19406

Dear Sirs:

Here is our renewal application for license # SNM-1266.

The only significant change to our previous renewal application, dated March 5, 1982 (copy attached) is the addition of the following paragraph to section 4:

4.4 John E. Smedley
Ph.D., Physics, University of Colorado, expected 1987. Semester courses in Atomic and Nuclear Physics and Electronics, Colby College. Courses in Quantum Mechanics, Instrumental Methods of Chemistry, Statistical Mechanics, and Reaction Dynamics, U. Colorado. On-site training in nuclear radiation laboratory experiments at Bates College will be provided upon arrival at Bates in fall, 1987.

Another minor change is my own title and phone number, specified in section 1. This section should now read:

1. Applicant:

Bates College
Department of Physics
Lewiston, ME 04240
(207) 786-6322
George A. Ruff, Professor

T. Hedley Reynolds,
President
Citizenship: USA

Thank you for your consideration.

Sincerely,

George A Ruff

George A. Ruff
Professor of Physics
(207) 786-6322

Renewal Application, License # SNM-1266
March 5, 1982

1. Applicant:

Bates College
Department of Physics
Lewiston, ME. 04240
(207) 784-9159
George A. Ruff, Chairman

T. Hedley Reynolds,
President
Citizenship: USA

2. Activities to be Performed:

Source to be permanently housed in paraffin-filled 55 gallon drum. Solid samples will be inserted into the drum for neutron activation experiments in an advanced undergraduate instructional physics laboratory.

3. Material Specification:

Pu-239: One sealed source, 5 Curie, Manufactured by Mound Laboratory, Monsanto Corporation.

4. Technical Qualifications of Personnel:

4.1 George A. Ruff

Ph.D., Physics, Princeton University, 1966. One year coursework in theoretical nuclear physics, including mathematics and calculations basic to use and measurement of radioactivity, Princeton University. Total of eight weeks in special training programs covering radiation measurement, standardization, monitoring techniques, and biological effects of radiation, Argonne National Labs, DCPA Staff College, and Miami University. Three years experience teaching undergraduate courses in nuclear radiation physics, including instrumentation and biological effects, Bates College.

4.2 John K. Pribram

Ph.D., Physics, University of Massachusetts, 1968. One year coursework in theoretical nuclear physics, U. Mass. Two years experience teaching introductory nuclear physics, one year experience teaching Laboratory Physics course involving basic radiation measurements, Bates College.

4.3 Gene A. Clough

Ph.D., Applied Physics, Caltech, 1976. One year coursework in theoretical nuclear physics and one year course in Laboratory Physics, including radiation measurements, Caltech. One year experience teaching elementary nuclear physics and advanced laboratory course involving nuclear radiation measurements, Bates College.

5. Facilities and Equipment (See also the attached drawing.)

5.1 Storage Facilities

Our facilities include a locked storage room, keys to which are available only to the authorized users named in section 4. The room has minimum wall thickness equal to 16 inches of concrete, and is equipped with underground storage wells. The paraffin tank in which the source is stored and used is always in this room.

5.2 Alpha detectors

1. ORTEC BA-23-50-100 surface barrier detector & associated electronics
2. Tracerlab SC-16 windowless flow counter
3. Ludlum 43-2 alpha probe & model 3 survey meter < 1.0 mg/sq. cm. window

5.3 Beta-Gamma Detectors

1. Beckman LS-100C liquid scintillation system
2. El-tronics LSC shielded well counter with NEC D-515 GM-tube
3. Ludlum model 3 survey meter with 44-7S probe, <2.0 mg/sq. cm. window

5.4 Gamma Detectors

1. Two NaI(Tl) scintillation detectors with SCA's, and a Nuclear Data 1100 multichannel analyzer are available.
2. Nuclear Chicago 1613A count rate meters with Raytheon CK1021 GM tubes. (4 available)

5.5 Miscellaneous

Additional facilities include about 50 lead bricks, remote handling tongs of 36 inch and 18 inch lengths, disposable rubber gloves, plastic trays, paper liners, and lead storage containers. A fume hood is located in the laboratory area.

6. Protection Procedures

6.1 Responsibility

George A. Ruff shall be responsible for radiation safety measures related to this source. His training is given in section 4.1. Access to the storage room containing the source shall be restricted to the individuals listed in section 4.

6.2 Personnel Monitoring

None required.

6.3 Radiation Survey

An upper limit to personnel exposure can be calculated in the following way:

A Pu-Be neutron source has a yield of 1E6 neutrons per second per Curie. (See Cember, Introduction to Health Physics, Pergamon, 1969, page 139.) Neglecting absorption in the tank and its walls, the 5 Curie source can produce no more than 165 thermal neutrons per square centimeter per second over the 3.3E4 square centimeter area of the tank. The activation of a sample requires less than 30 seconds in the storage room. Assume all this time is spent in direct contact with the tank surface. The absorbed dose rate to a 70 Kg person of 160 cm height is calculated for a thermal neutron flux of 1E4 neutrons per square centimeter per second to be .74 mrad/hr due to the $^{14}N(n,p)\ ^{14}C$ reaction, and 7.7 mrad/hr due to the $^{1}H(n,\gamma)^{2}H$ reaction. (See Cember, Introduction to Health Physics, Pergamon Press, 1969, page 174.) Assigning quality factors of 1 to the gamma rays and 10 to the protons, the total dose equivalent to the individual for a 1E4 neutron flux is 15.1 mrem/hr. The corresponding figure for a flux of 165 is .25 mrem/hr, or 2.1E-3 mrem for a 30 second exposure.

The normal enrollment in our Laboratory Physics course is less than 20 students. If 20 students each chose to do the neutron activation experiment, individually, in a calendar quarter, the maximum dose equivalent to the individual exposing the samples would be 4.2E-2 mrem, or 0.013 percent of the maximum permitted dose of 0.31 rems per calendar quarter.

Wipe testing of the source presents another occasion of personnel exposure. During this operation, the source is removed from the paraffin tank. The individual performing the test is exposed to 4 MeV neutrons at a distance of 1 meter from the source for a time less than 60 seconds. The first collision dose rate for elastic scattering of 5 MeV neutrons in tissue is calculated to be 28.8 mrad/hr for a neutron flux of 2E3 neutrons per square centimeter per second. (See Cember, Introduction to Health Physics, Pergamon, 1969, page 172. At a distance of 100 cm from a 5 Ci Pu-Be source, the flux is 40 neutrons per square centimeter per second, resulting in a dose rate of 0.6 mrad/hr. Assigning a quality factor of 10 to fast neutrons, the resulting radiation dose equivalent rate is 6 mrem/hr, or 0.1 mrem per 60 second exposure during a wipe test. This is approximately 0.03 percent of the maximum permitted dose of 0.31 rems per calendar quarter.

6.4 Waste disposal

No wastes will be generated under the proposed program.

6.5 Record Management

Wipe test records will be kept in a bound notebook in the source storage room. License and inventory records will be maintained in the office of the physics department Chair.

6.6 Material Control

No special nuclear materials will be ordered or received under the proposed program.

6.7 Leak Testing

The source is normally contained in the paraffin filled tank, and is removed only for wipe testing by one of the users specified in section 4 above. The source is permanently mounted at one end of an 18 inch long polyethelene rod, the other end of which is handeled by the user. A small piece of moist paper towel, itself held with 18 inch tongs, is wiped over an exposed source surface, and the source is immediately returned to the tank. The towel fragment is then counted for alpha emission using one of the following counters and associated counting geometries:

1. Tracerlab Model SC-16 windowless flow counter: When this instrument is used, the towel fragment is inserted into the active volume of the detector. The air admitted to the chamber is then purged with an appropriate counting gas and the counting gas is kept at a slight positive pressure while the count is being taken.

2. ORTEC model BA-23-50-100 surface barrier detector: When this detector is used, the towel fragment is placed with the detector in a sealed counting chamber. The distance between the fragment and detector is less than 10 centimeters. Air is evacuated from the chamber to a pressure less than 0.05 Torr.

3. Ludlum model 43-2 alpha probe: Since this detector has an aluminized mylar window of <1.0 mg/sq-cm thickness (equivalent to <0.8 cm range in air for 5 MeV alpha particles), and since the range in air for 5 MeV alpha particles is 3.6 cm, the towel fragment must be within 2.8 cm of the detector window if radiation is to enter the active volume of the probe. Therefore this detector will be used only if the fragment to window distance does not exceed 1.0 cm.

4. El-tronics LSC shielded well counter with NEC P-515 (or equivalent) GM-tube: Since this detector has a mica window of <2.0 mg/sq-cm thickness (equivalent to <1.2 cm range in air for 5 MeV alpha particles), and since the range in air for 5 MeV alpha particles is 3.6 cm, the towel fragment must be within 2.4 cm of the detector window if radiation is to enter the active volume of the tube. Therefore this detector will be used only if the fragment to window distance does not exceed 1.0 cm.

The same detector is then used to count a 0.005 microcurie Am-241 standard source. If the count rate from the towel fragment exceeds that from the standard, the normally capped tank openings will be sealed with plastic tape to await the arrival of an appropriately licensed decontamination and waste disposal service, specifically Interex, Inc., of Natick, Mass.

6.8 General Safety Instructions

The users specified in section 4, above, will be provided with copies of this license application, and the use and wipe test provisions contained herein will be reviewed by them as a group.

6.9 Emergency Procedures

In the event that removable contamination in excess of 0.005 microcurie is detected during a wipe test, the capped ports of the paraffin tank will be sealed with plastic tape. A wipe test will then be done on the outer surface of the tank, near each of the capped ports normally used for the insertion of samples, and also near the port used to remove the source itself. If removable contamination exceeding 0.005 microcurie is found on this surface, the normally locked door to the storage room will be sealed with plastic tape. The user will then survey his own person, using one of the alpha-sensitive probes specified in section 6.7, checking the probe with the 0.005 microcurie standard if this has not already been done as part of the wipe test procedure. If detectable contamination is found, cleanup via detergent, water, and paper towels will be executed in the nearest laboratory sink in such a way as not to release waste water to the sewer system. After cleanup, the sink will be covered with a plastic seal. Access will be forbidden to all rooms where detectable contamination has been observed, and an appropriately licensed decontamination and waste disposal service (Interex, Inc., Natick Mass.) will be called in.

6.10 Training of Personnel

The users specified in section A above will review as a group all material and procedures contained in this application. Follow-up reviews will occur whenever the license is amended or renewed.

Department of Physics
By:

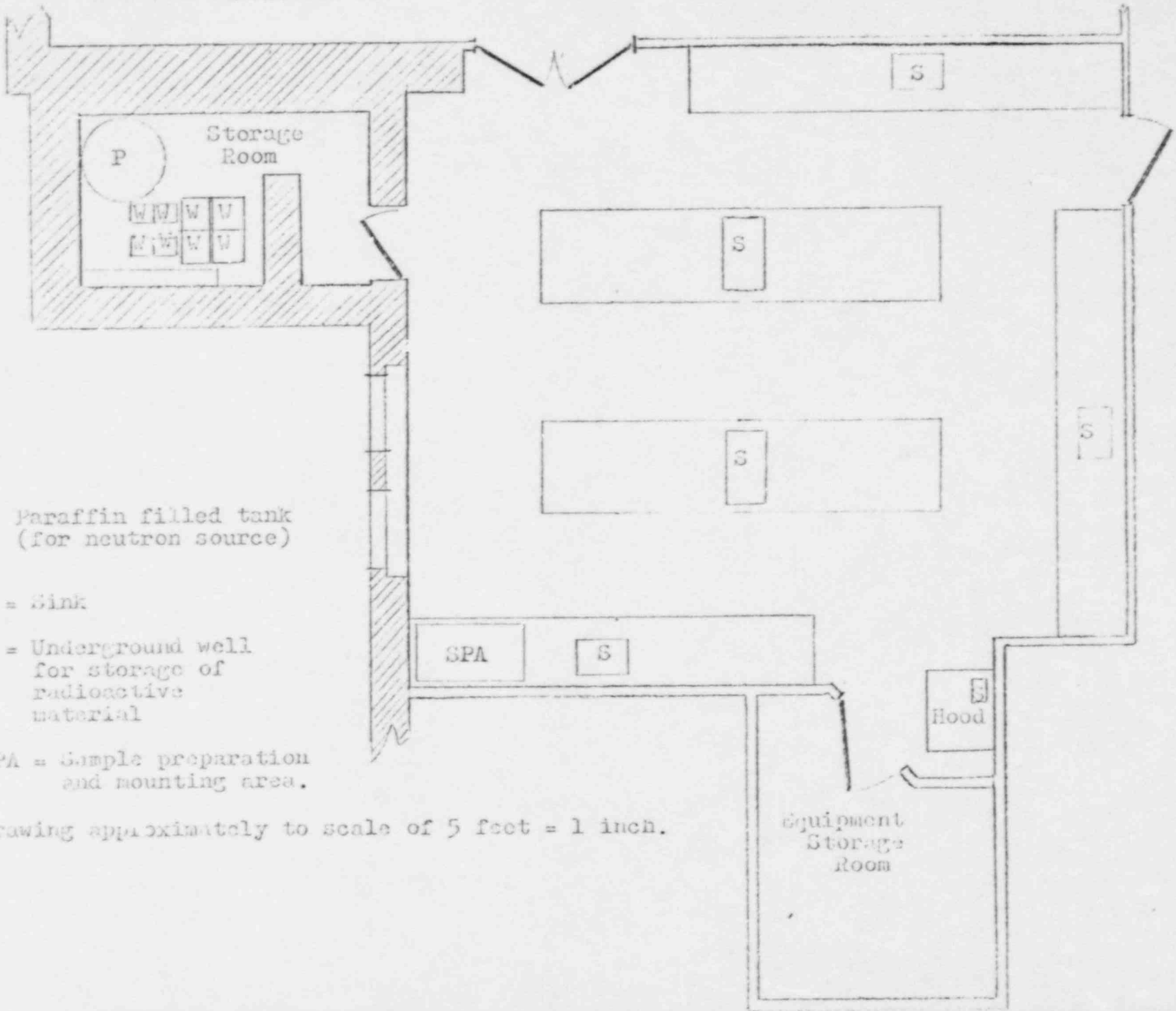
George A. Ruff

George A. Ruff
Chairman

Bates College
By:

Bernard R. Carpenter
Vice President for Business Affairs

Supplementary Drawing: Laboratory and Storage Facilities




P Paraffin filled tank (for neutron source)

S = Sink

W = Underground well for storage of radioactive material

SPA = Sample preparation and mounting area.

Drawing approximately to scale of 5 feet = 1 inch.

Fee Exempt

BETWEEN: William O. Miller, Chief
License Fee Management Branch
Office of Administration

John E. Glenn, Chief
Nuclear Materials Section B
Division of Engineering and
Technical Programs

070-01297
2-120
3/87

LICENSE FEE TRANSMITTAL

A. REGION I

1. APPLICATION ATTACHED

Applicant/Licensee: Bates College

Application Dated: 2-26-87

Control No.: 106854

License No.: SNM-1266

2. FEE ATTACHED

Amount: _____

Check No.: _____

3. COMMENTS

Signed _____

Date _____

B. LICENSE FEE MANAGEMENT BRANCH

FEE EXEMPT

1. Fee Category and Amount: EX 1K 170.11(a)(4)

2. Correct Fee Paid. Application may be processed for:

Amendment _____

Renewal ✓

License _____

Signed D. Kirkherley

Date 3/5/87

REGION I FORM 213
(MARCH 1983)