 September 29, 1978

Radioisotope Licensing Branch
Division of Fuel Cycle & Material Safety
Office of Nuclear Material Safety & Safeguards
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Re: SNM-656
Docket No: 70-709
RIS: ZEZ

Gentlemen:

The University of Delaware, Newark, Delaware hereby makes application for renewal of Special Nuclear Material License Number SNM-656.

The following information is submitted in seven(7) copies in fulfillment of Section 70:22, Title 10, Code of Federal Regulations, Part 70 "Special Nuclear Material" and in accordance with U.S. Nuclear Regulatory Commission Regulatory Guide 10.3, Sections 4 and 6.

1. Specification of Applicant

The University of Delaware, Newark, Delaware was made a Land-Grant College by act of the Delaware General Assembly in 1857. It is thus organized in and by the State of Delaware.

The principal office of the University is located in Hullihen Hall, University of Delaware, Newark, Delaware 19711.

The principal officers of the University are:

Name	Title	Address	Citizenship
Edward A. Trabant	President	47 Kent Way Newark, DE 19711	United States
L. Leon Campbell	Provost & Vice President for Academic Affairs	76 Polly Drummond Rd. Newark, DE 19711	United States

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

2. Specification of Activities

a. One Pu-Be neutron source M233 will continue to be held in storage by the Department of Electrical Engineering in Room 241 of P.S. duPont Hall Laboratory, Main Campus, or used as a calibration source for neutron detection instruments.

b. One Pu-Be neutron source N800I18 will continue to be used in the Nuclear Physics Laboratory of Sharp Laboratory, Main Campus.

The source will be used for educational instructional purposes. It will be used in the two specific experiments in the second half of the one year senior laboratory course PS 617/618.

1) n-gamma discrimination

A liquid scintillator NE-213 will be placed near the howitzer's side port to detect the neutrons and gamma photons. Standard pulse shape discrimination technique will be applied for distinguishing neutrons from gamma counts. The student will be sitting in the control room of the accelerator laboratory with the electronic console. The signals from the liquid scintillator are sent through a conduit under ground via coaxial cables.

2) neutron activation analysis

A short-lived isotope like Mn-56 will be produced by irradiating Manganese powder in plastic pouches. The pouches will be placed in the lucite sample-holding rod of the howitzer. The rod is then slid into the vicinity of the source inside the howitzer for irradiation. After irradiation the rod can be pulled out and the activity will be counted in standard gamma photon counting set-up in the nearby laboratory reserved for the PS 617/618 course.

In both experiments the Pu-Be source shall remain inside the howitzer and the howitzer will be kept inside the accelerator vault.

3. Specification of Special Nuclear Material

The University of Delaware possesses two(2) Plutonium-Beryllium sources totaling approximately 96 grams of Plutonium in source Nos., M233 and N800I18 given in Grant Number MG-179-73 RIS:ZEZ to the University of Delaware by the Laboratory Relations Branch, Division of Nuclear Education and Training, USAEC, on February 13, 1973. This grant replaced Loan Agreement R2(1958) and 62-6.

a. Source No. M233 of approximately 16 grams of Plutonium and one(1) Curie of activity was manufactured by Monsanto Research Corporation, Mound Laboratory, Miamisburg, Ohio.

The source is stored and secured by lock and key in its original shipping container which is a 15-gallon drum filled with paraffin. The shipping container has a 15-inch diameter.

The source is described as 15.93 grams Plutonium contained in Tantalum and stainless steel having dimensions of 1.06" O.D. x 1.58" H, 10-32 thread.

b. Source No. N800I18 of approximately 80 grams Plutonium and 5 Curies of activity was fabricated by Nuclear Materials and Equipment Corporation, Apollo, Pennsylvania.

The source is stored, used, and secured when stored by lock and key in a neutron howitzer model NR-2 manufactured by U.S. Nuclear Corporation, P.O. Box 208, Burbank, California. A print of the details and dimensions of this howitzer were enclosed with the University's previous application dated October 10, 1962. This print is U.S. Nuclear drawing number E-0050.

The source is described as 74.42 grams Plutonium contained in Tantalum and stainless steel having dimensions of 1.63" O.D. x 2" H.

c. This renewal application requested a possession limit of ninety-six (96) grams of Plutonium encapsulated as two(2) Pu-Be neutron sources.

4. Technical Qualifications of Personnel

Course Instructors

Cheng-Ming Fou, PhD., Associate Professor of Physics

1956 B.Sc. National Taiwan University, Taiwan China
1961 Dipl. Phys. Universität München, Munich, Germany
1965 PhD. University of Pennsylvania, Philadelphia, Pa.
1965-68 Research Associate, Univ. of Penn., Tandem Accelerator Laboratory
1968 Assistant Professor of Physics, University of Delaware
1972 Associate Professor of Physics, University of Delaware

Recent Publications

Investigation of ^{9}B and ^{9}Be Levels in Kinematically Complete $^{9}B(p,pn)^{8}Be$, J.M. Chou, C.M. Fou, C.S. Lin, Y.C. Liu, P.S. Sung, and M. Wen, Journal of Physical Society of Japan, 44, 1 (1978).

Characteristics of the First Excited State of He-5, C.M. Fou, Y.C.Liu, C.C. Hsu, and S.L. Huang, J. Phys. G. 11 847 (1976).

Study of Multi-particle Final State Interaction with a Pulsed Beam, J.C. Chou, C.M. Fou, C.S. Lin, Y.C.Liu, P.S. Sung, and M. Wen, Nucl. Instr. Methods 130, 157 (1975).

The Characteristics of the Third Excited State of Li-6, H. Schwartz and C.M. Fou. J. of Phys. G7 , L57 (1975).

The Excitation Energy of the First Excited State of ^{9}Be, C.M. Fou and P.T. Wu, Canadian J. Phys. (1975).

The Characteristics of the First Excited State of ^{5}Li, R.M. Gagne nad C.M. Fou, Journal de Physique 36, 759 (1975).

Dr. Fou has served on the Radiation Safety Committee of the University of Delaware since 1976 and served as chairperson of that committee during the 1977-1978 academic year. He is also an authorized permit supervisor under the University's Broad "A" NRC license #07-01579-19.

C.B. Cooper, PhD., Professor of Physics

1950 PhD., Physics, University of Maryland
1944-46, Technical Supervisor, Manhattan Project, Oak Ridge, Tenn.
1946-49, Instructor, Physics, University of Delaware
1951-52, Assistant Professor of Physics, University of Maryland
1952-58, Vice-President, Tagcraft Corporation
1958-65, Associate Professor of Physics, University of Delaware
1965 Professor of Physics, University of Delaware
1968-69 Acting Chairperson, Dept. of Physics, University of Delaware

Recent Publications

Analysis of Pb-azide Thin Films by Rutherford Backscattering, H.M. Windawi, C.B. Cooper, and F.E. Williams, J. Appl. Phys., 47, 3418 (1976).

AES Depth Profiling with N_2^+ Ion Sputtering, H.M. Windawi, J.R. Katzer, and C.B. Cooper, Phys. Lett. (Neth.), 59A, 62 (1976)

A Combined UHV Ion Scattering and Secondary Ion Mass Spectrometer Utilizing a Magnetic Sector Magnet, L.L. Tongson and C.B. Cooper, J. Phys. E., 10, 1245 (1977).

Dr. Cooper has been active in the field of surface physics for about thirteen years. He has in addition to the above publications about 35 others. Dr. Cooper served as Radiation Safety Officer for the University during 1963-1965 and has been supervisor of NRC license #SNM-656 for a number of years.

Radiological Safety

Jenny M. Johansen, M.S., Safety Coordinator/Radiation Safety Officer

1965 B.A. Concordia College, Moorhead, Minnesota
1969 M.S. Radiological Health Physics, North Dakota State University, Fargo, N.D.
1969-70 Research Assistant, Radiation Safety Officer, Virology and Tissue Culture Lab., Tufts Medical School, Brockton V.A. Hospital, Brockton, Mass.
1970-71 Health Physicist/Chemist, Radiation Safety Officer, Division of Nuclear Medicine, Peter Bent Brigham Hospital, Boston, MA.
1970-74 Health Physicist, Assistant Radiation Safety Officer, Joint Center for Radiation Therapy, Boston, MA.
1974 - Radiation Safety Officer, University of Delaware.
1975- Appointed Instructor, College of Graduate Studies, University of Delaware
1976 - Safety coordinator/Radiation Safety Officer, University of Delaware.

Ms. Johansen has extensive experience with handling, storage, and safe use of the various radioactive nuclides used in Nuclear Medicine, Radiation Therapy, and Research. In addition, she is the Radiation Safety Officer of record under the University's NRC Broad"A" license 07-01579-19 and serves as Executive Secretary of the Radiation Safety Committee. Complete list of radionuclides Ms Johansen has used listed in the University's application for Broad "A" license dated December 3, 1974. Ms. Johansen also teaches a course on safe handling of radionuclides to graduate students who are going to use radionuclides in research.

Supervisor Source #M233 (in storage)

Bruce C. Lutz, Ph.D., Professor of Electrical Engineering

1942 B.A. Physics University of Western Ontario
1944 M.A. Physics " " " "
1954 Ph.D. Physics, Johns Hopkins University
1944-45 Instructor, Lieutenant RCNUR
1945-47 Lecturer in Physics, University of Manitoba
1947-55 Instructor in Physics, University of Delaware
1955-57 Assistant Professor of Physics, University of Delaware
1957-62 Associate Professor of Physics, Electrical Engineering, University of Delaware
1962 Professor of Electrical Engineering, University of Delaware

Dr. Lutz has served as supervisor of NRC License R-043 covering the AGN-201 nuclear reactor from 1958 until May, 1978. License R-043 has been terminated by the NRC as the reactor was defueled and decommissioned in December of 1977. Before the time of the defueling, the Pu-Be neutron source M233 previously covered by R-043 was transferred to NRC License #SNM-656 by Amendment #3 dated October 17, 1977 and requested by letter dated September 23, 1977.

Dr. Lutz has held a Senior Operator's License #SOP-313 and supervised NRC (AEC) license 07-01579-02 before its termination in 1975. Dr. Lutz has served on the Radiation Safety Committee since it was formed in 1957 and was chairperson during the 1975-76 academic year.

5. Description of Equipment, Facilities and Instrumentation

a. Remote handling tools

Source No. N800I18 has a two foot long handling tool supplied by U.S. Nuclear Corporation.

Source No. M233 has a two foot long handling tool which is attacned to it.

b. Storage containers, facilities and instrumentation

1) Storage containers are previously described under items 3a and 3b, and provide adequate shielding of the neutron sources. In addition, source No. N800I18 in its howitzer is stored inside the van de Graff accelerator vault which is located in the basement of Sharp Laboratory. The vault is surrounded on all sides by high density concrete 90 cm thick. Signal cables are pulled through underground conduits and the entrance to the vault is shielded by a concrete maze. The door to the maze contains 2 cm thick lead. The door to rooms 014C, D, E, which is the accelerator complex is kept locked when an authorized person from the Department of Physics is not in the immediate area. A diagram of Sharp Lab basement is attached to this application.

2) Source No. M233 is stored in a small room within Room 241, P.S. duPont Hall. This small room formerly contained a 250 Kev x-ray unit which has been removed. In the walls, doors, ceiling and floor of this small room is 1/4" lead shielding. The door to Room 241 is kept locked unless used by an authorized person from the Department of Electrical Engineering. These persons do not enter or use the small x-ray room. A diagram of P.S. duPont Hall is attached to this application.

3) Radiation detection instruments

The following radiation protection instrumentation is available for Source No. N800I18:

Instrument & Manufacturer	Radiation Detected
Alpha Survey Meter, Nuclear-Chicago Corporation, Model 2672	Alpha
Neutron Survey Meter, Nuclear-Chicago Model 2671	Fast & thermal neutrons

Description of the above instruments:

Nuclear-Chicago Corporation Alpha Survey Meter, Model 2672 - This instrument consists of a count rate monitoring unit, and an alpha probe that houses a thin window air proportional detector with a high gain pre-amplifier. The probe has a window with 80 cm^2 of sensitive area. Sensitivity to a point source at the center of the window averages 90% of maximum. The efficiency is approximately 12% for alpha particles from RaD + E or Uranium Oxide (for 2π geometry). The efficiency for betas and gammas is 0.1%. The maximum background is 5 cpm, or about 0.0833 counts/second.

Nuclear-Chicago Model 2671 transistorized neutron portable survey meter. This instrument consists of a Nuclear-Chicago Model 2646 Neutron detector and Model 2673 neutron portable count rate meter. The instrument is intended for general survey work for detection of fast neutrons. By removal of the wax moderator and cadmium shield from the detector tube, the Model 2671 may be used for detection of thermal neutons. Gamma discrimination for the Model 2671 is such that a negligible response is produced in a gamma flux of 5 roentgens per hour from radium.

The Model 2646 Neutron Detector has a sensitivity for neutrons such that approximately 1 count per second is produced in a flux of 10 neutrons per square centimeter per second from a radium-beryllium neutron source. The sensitivity for thermal neutrons without the wax moderator and cadmium shield is approximately 3 counts per second produced in a flux of 10 neutrons per square centimeter per second. The moderator is approximately one inch of wax. A 20 mil cadmium shield extends along the length of the tube, but the end is left open. The detector tube is a BF_3 gas filled chamber for proportional counting having a pressure of 30 centimeters of mercury. The detector is not sensitive tc alpha, beta or gamma radiation fields of high intensity.

In addition the Radiation Safety Office has on hand the following instruments available to use for both neutron sources:

Instrument & Manufacturer	Radiation Detected	Sensitivity	Window mg/cm^2	Use
Victoreen-490 with 489-35 probe	α, β, γ	0-80,000 cpm 0-20 mR/hr	1.4	Survey
489-4 probe	β, γ	0-80,000 cpm 0-20 mR/hr	30	Survey
489-50 probe	γ	0-200 mR/hr	NaI(Tl) 1x1"	Survey
Victoreen-440	β, γ	0-300 mR/hr	3.0 without cap	Survey Measuring
Victoreen-444	α, β, γ	0-300 mR/hr	1.5	Survey Monitoring
Victoreen Radector III	β, γ	0.1 mr/hr-1 Kr/hr		Monitoring
Eberline PAC-4G-3 with AC21 probe	α	0-500,000 cpm	0.85	Survey Measurement
" AC21B probe	β	0-500,000 cpm	0.85	Survey Measurement
" TP-1 probe	β	0-500,000 cpm	Windowless	Survey Measurement
Eberline PNR-4	n	0-5,000 mREM	-	Survey Measurement Assaying
Eberline MS-2 with proportional gas flow FC-1 detector	α, β	0-500,000 cpm	Windowless	Measuring

Calibration of Survey Meters

n-Detection instruments will be calibrated at various distances in air against the 1 Ci Pu-Be neutron source #M233 which has a reported flux of 1.86×10^6 n/sec (1962). We will assume an average neutron energy for Pu-Be of 3.4 MeV (NBS publication 456 "Measurement for the Safe Use of Radiation, p. 89, 1976) and a conversion factor of approximately 28×10^6 n/cm^2 = 1 Rem (General Dynamics Health Physics Handbook, p. 163, 1963). The assumed radiation flux relation to source strength for point sources is $\phi = S/(4\pi R^2)$ where ϕ is n/cm^2/sec, s is n/sec and R is distance in cm. Relationship of $\phi_1 = \phi_2(R_2/R_1)^2$ is used. The source was given to the University by AEC, traceable to NBS is assumed. Concrete shielding is placed on three sides of the Pu-Be source for protection. Detection chambers and survey meter are separated by a 36" cable. PuBe source has a tolerance distance in air of 22 inches giving 55 n/cm/sec which is equivalent to 0.3 Rem in 40 hours exposure.

Alpha detection instruments and probes are calibrated against 4-Eberline Certified Pu-239 sources traceable to NBS within a 0.2% agreement. The sources are of 0.0003 uCi SN#7418, 0.0030 uCi SN#7419, 0.0337 uCi SN#7420, and 0.3731 uCi SN#7421, giving disintegration rates of 690 ± 15, 6,700 ± 130, 74,700 ± 1,500, 827,400 ± 16,500 assuming 1.5% backscatter of alpha particles from the surface of the disk and 2π geometry in the source holder in which the source is recessed by 1 mm.

The instruments are calibrated on 2 scales compatible to sources with the probe at a distance of 1 mm from the surface of the α source, instruments will be adjusted to read within ± 10% of source values.

Beta detection instruments and probes are calibrated against 4-Eberline Certified Tc-99 sources traceable to NBS within a 0.2% agreement. The sources are of 0.0002 uCi SN#7415, 0.0025 uCi SN#7416, 0.0256 uCi SN#7417, and 0.2289 uCi SN#139/71, giving disintegration rates of 550 ± 15, 5,650 ± 170, 56,820 ± 1710 and 507,500 ± 15,200 assuming 25% backscatter of beta particles from surface of the disk and 2π geometry in the source holder in which the source is recessed by 1 mm.

The instruments are calibrated on 2 scales compatible to the source with the probe at a distance of 1 mm from surface of the source, instruments will be adjusted to read within ± 10% of source values.

Gamma detecting instruments and probes are calibrated against a 100 mCi CS-137 USN type 375, SN F171 source mounted in a JLS Series 10 Calibrator, SN 598 as is directly traceable to NBS, having an output of 100 mR/hr at 50 cm and a 20^{o} beam port.

The instruments and probes are calibrated at certain distances in air along the center of the beam port which will give a 1/2 scale reading at 2 scale settings on the instrument.

The distance from the source for 1/2 scale reading is first calculated. With the port of calibrator closed, the instrument is placed in line with the calibration port at the distance calculated and measured. The scale on the instrument is placed so it can be seen from behind the calibrator. The calibration port is then opened and the exposure rate on the instrument is read. The port is closed and adjustments made to the instrument if necessary to bring the reading to ±10% of exposure rate calculated for the distance. The process is repeated until the adjustment to ±10% is reached. The person performing the calibration is always behind the calibrator when the beam is open. The port is opened with a remote handling tool. If the instrument cannot be placed so the scale is readable, a mirror is placed so that the scale can be seen from behind the calibrator. Binoculars are also available so that the scale can be seen with greater accuracy from behind the calibrator. Calibrations are performed by either one of the course instructors or the Radiation Safety Officer at six month intervals at the location of the Pu-Be source in duPont Hall or the basement of the Radiation Safety Office.

6. Procedures to Protect Health and Minimize Danger

The very first lecture of the PS 617/618 course using Source No. N800I18 will be on radiation safety in which the relevant paragraphs of the University of Delaware Radiation Safety Manual (UDRSM) will be explained. The use of radiation monitors and survey meters will be shown.

Throughout the semester at each laboratory session, the area which the students occupy while the experiment is in progress will be surveyed to ascertain the radiation levels. Each student will carry a personalized pocket dosimeter. The readings of these dosimeters will be recorded before and after the laboratory session.

For the experiments described, the students are near the neutron howitzer for approximately ten (10) minutes in order to either adjust the position of the liquid scintillator or to slide the sample in or out for irradiation. An estimated total accumulated exposure of 0.2 mRem/hr for the one (1) hour laboratory session can be expected. This exposure is well below 25% of MPD values stated in 10 CFR-20 and conform to "ALARA" philosophy.

The sealed source is not removed from the howitzer at any time during the laboratory sessions, periodic surveying of the radiation level around the howitzer immediately outside the port with and without the port plug in place will be carried out and results posted near the howitzer to inform the students coming in to do the experiment.

At the end of each day of use, the howitzer will be surveyed to determine if the neutron source is in the storage position.

When not in use the neutron Source No. N800I18 will be stored in the storage position of the U.S. Nuclear NR-2 howitzer. The side ports and top closure port will be locked at all times, with the key available only to the laboratory instructors, chairperson of the Physics Department and Radiation Safety Officer.

For Source No. M233 which shall remain in storage, the key for the lock is controlled by Dr. Bruce C. Lutz of the Department of Electrical Engineering and available to the Radiation Safety Officer for calibration purposes.

a. Specification of Radiation Safety Responsibilities and Duties

Although written for NRC License 07-01579019, the University of Delaware Radiation Safety Manual covers all NRC licensed activities at the University of Delaware. The purpose, organization and responsibilities of the University Radiation Safety Committee are outlined in Sections 1.1, 1.2 and 1.3 and of the Radiation Safety Officer in Sections 2.1 and 2.2. Qualifications of the Radiation Safety Officer are stated under Section 4 of this application.

b. Personnel Monitoring

Students in PS 617/618 will wear Bendix Model 884 fast neutron - γ tissue equivalent dosimeters having a detection range of 0-200 mRem for measurement of whole body exposure.

Other personnel monitoring requirements are covered by Section 3.8 UDRSM. Film badges for whole body fast neutron - γ are supplied by R. S. Landauer, Jr., & Company, Glenwood, Illinois on a bi-weekly basis.

c. Radiation Safety Program

Surveys to be carried out during the PS 617/618 course are described in the paragraphs under Item 6. In addition the Radiation Safety Officer surveys the howitzer and storage container of the two Pu-Be sources on a quarterly basis during leak testing procedures for η, γ radiation levels.

d. Record Management

Log of surveys conducted during student experiments will be kept by the course instructor. All other records pertaining to the Pu-Be sources are kept by the Radiation Safety Officer with copies in the Departments of Physics and Electrical Engineering.

e. Sealed Source Leak Testing

All leak testing is performed by the Radiation Safety Officer or the Health Physics Technologist under direction of Radiation Safety Officer. Qualifications of Radiation Safety Officer are stated under Item 4. Leak testing is carried out by smearing the surface of the sources with a cloth smear attached to an 18" forceps.

Smears are counted on an Eberline Model F-1 windowless gas flow detector attached to Eberline Model MS-2 miniscaler rate meter.

Each smear is evaluated by comparison to count rate received on alpha plateau of proportional counter of an Eberline Serial #7422 Pu-239 disk source of 0.0046 uCi $\pm$ 2% traceable to NBS. Pu-Be sources are leak tested on a quarterly basis.

f. General Safety Instructions

A copy of the UDRSM is submitted with this application. Sections 3.3 and 3.5.2 apply.

g. Emergency and Decontamination Procedures

These are listed in Section 4.0 of UDSRM and the call list in Section 4.7 is posted in the lab rooms where the Pu-Be sources are kept. The Radiation Safety Officer would supervise any problem such as a source rupture which would require decontamination.

h. Procedures for Training of Personnel

1) A description of the training for students taking PS 617/618 is described in the paragraphs under Item 6.

2) Source No. M233 is in storage and will be used only for calibration purposes in the forseeable future, but should a project be proposed for its use, the persons who may be involved in or associated with the use of this source must fulfill the requirements of the Radiation Safety Committee for authorization as outlined by the UDRSM, Sections 3.1, 3.2, pages 5-9.

Persons not fulfilling these requirements may be trained on the job under the direction of Dr. Lutz, this on-the-job training to cover items listed on the Instruction Check-Off List found in Appendix A of UDRSM. Persons trained on the job must pass a written examination covering the radioisotope or radiation device for which they are requesting authorization to use. Also the Radiation Safety Committee may require persons not fulfilling the requirements to complete the one semester, three credit hour formal course, "Safe Handling of Radioisotopes," U-675, taught by the Radiation Safety Officer. This course covers items outlined on NRC (AEC) Form 313, Section 8.

In addition an amendment to License SN[illegible]-656 for the specific purpose would be sent to the NRC for approval to use Source No. M233 for the project proposed.

7. Period of License

Renewal of this license is requested for a five year period.

Sincerely,

Edward A. Trabant, Ph.D.
President

Application Approved
Department of Physics

Cheng-Ming Fou, Ph.D.
Associate Professor of Physics

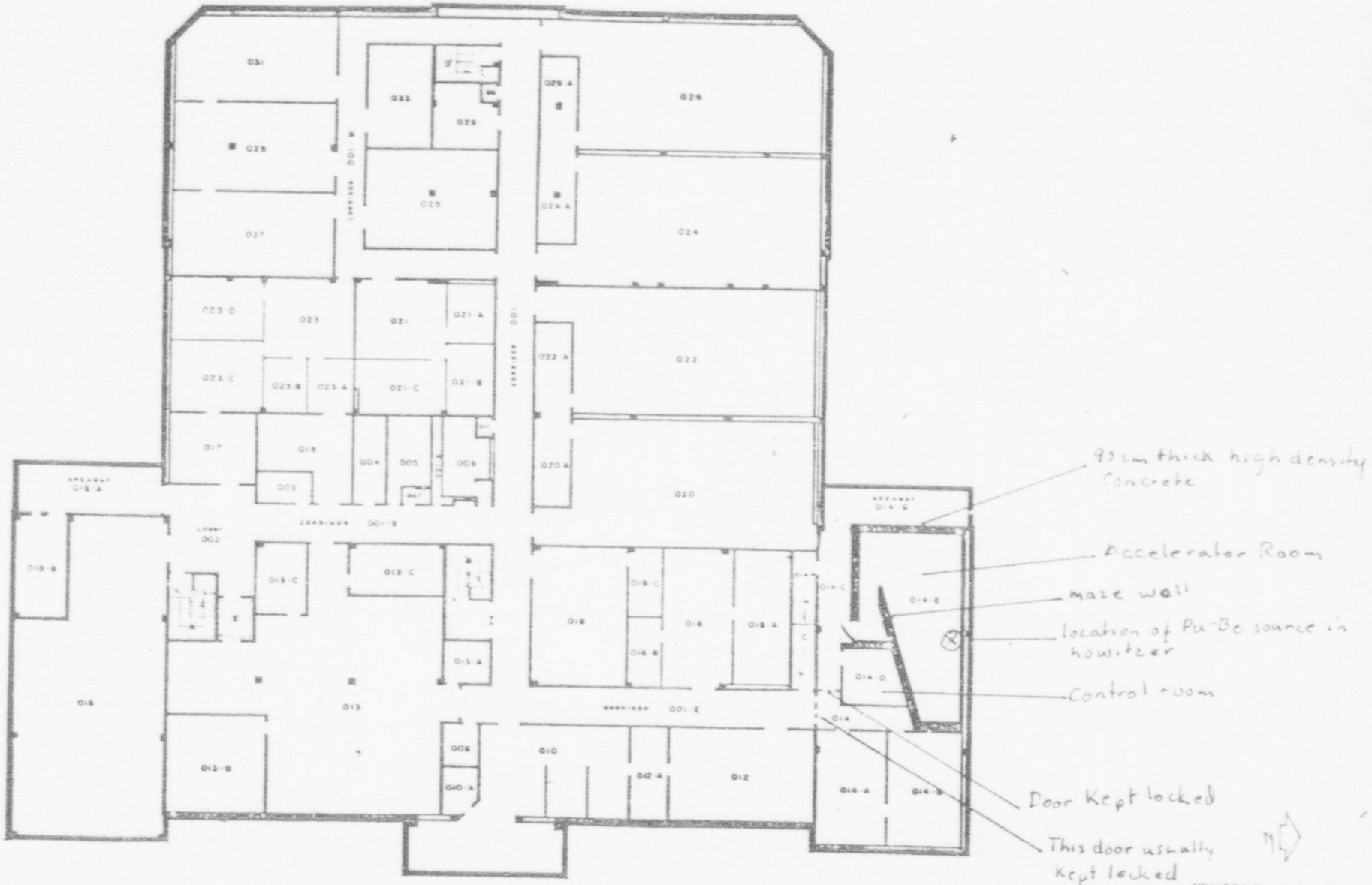
Charles B. Cooper, Ph.D.
Professor of Physics

Application Approved
Department of Electrical
Engineering

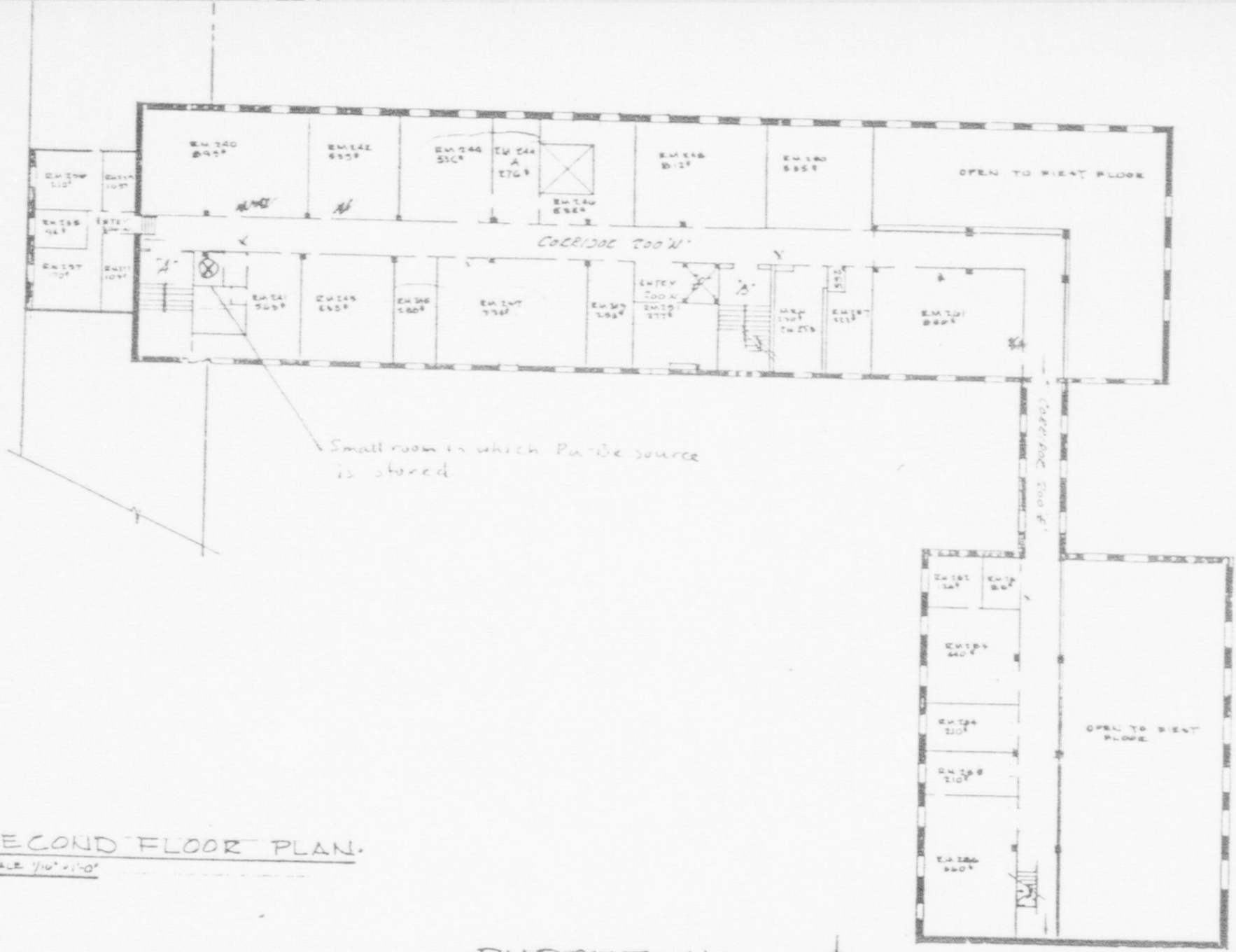
Bruce C. Lutz, Ph.D.
Professor of Electrical Engineering

Application prepared by
and Approved for the
Radiation Safety
Committee

Jenny M. Johansen, M.S.
Safety Coordinator/Radiation Safety Officer



GROUND FLOOR PLAN

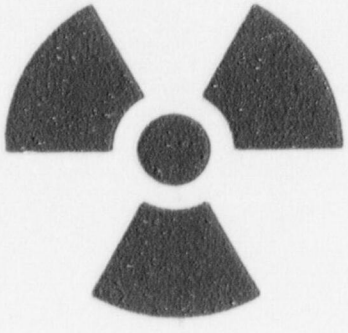


SECOND FLOOR PLAN.

SCALE 1/16" = 1'-0"

DUPONT HALL

RADIATION SAFETY MANUAL



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UNIVERSITY OF DELAWARE

RADIATION SAFETY MANUAL

References to AEC in this
Manual should be changed to
NRC

Prepared and Written by:

Jenny M. Johansen, M. S.
Radiation Safety Officer

R. L. Salsbury, Chairman

Approved by Radiation Safety Committee
Date: Nov. 26, 1974

Arnold L. Lippert

Approved for the University Administration
by the Associate Provost of Research

Date: 12/2/74

DEDICATION

From its first organization as the Committee on Atomic Energy Activities on August 2, 1957, the Radiation Safety Committee has continued to serve the University of Delaware community in solving problems of radiation safety in research.

From the "grass roots" committee of five to its present membership of ten, the committee represents the disciplines of the University engaged in research and development.

In the past, several members have served not only as a member of the faculty but also as the Radiation Safety Officer. To those members listed below, the Radiation Safety Committee dedicates this Radiation Safety Manual as a token of our appreciation for their services to the University and the Radiation Safety Committee.

1957 - 1963	Dr. John H. McClendon
1963 - 1965	Dr. C. Burleigh Cooper
1965 - 1967	Dr. Conrad N. Trumbore
1967 - 1971	Dr. Richard B. Murray
1971 - 1973	Dr. Robert L. Salsbury
1973 - 1974	Dr. Robert Gagne

Members of the Radiation Safety Committee - 1974 :

Dr. Robert L. Salsbury, Agriculture, Chairman
Dr. Olaf P. Bergelin, Coordinator of Research
Dr. C. Burleigh Cooper, Physics
Mrs. Sheila Cushing, Nursing
Miss Jenny M. Johansen, Radiation Safety Officer, Executive Secretary
Dr. Bruce C. Lutz, Electrical Engineering
Mr. M. D. Machnovitz, Safety
Dr. Jonathan H. Sharp, Marine Studies
Dr. G. Fred Somers, Biological Sciences
Dr. Conrad N. Trumbore, Chemistry

RADIATION SAFETY MANUAL

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1.0. THE RADIATION SAFETY COMMITTEE

1.1. PURPOSE OF THE RADIATION SAFETY COMMITTEE

The purpose of the Radiation Safety Committee of the University of Delaware is the promotion of the best practice in safe handling and use of radioisotopes and radiation producing devices throughout the University campus, regional campuses, affiliated institutions and properties throughout the State of Delaware.

The establishment of a Radiation Safety Committee is required by the federal government before an institutional program for the use of radioisotopes in research and development under a broad scope will be licensed.

Federal and state government regulations concerning radioisotopes shall be implemented by the action of the committee in association with individual radioisotope users, department heads and the administration of the University.

Radiation, as used herein, includes x-rays, gamma rays, alpha and beta particles, high speed electrons, neutrons, protons, and other nuclear particles; but not sound or radio waves, or visible, infrared and ultraviolet light.

1.2. ORGANIZATION OF THE RADIATION SAFETY COMMITTEE

The Radiation Safety Committee shall be appointed by the Provost or the Associate Provost for Research.

Membership shall consist of faculty or professional staff experienced in handling radioisotopes, the use of radiation producing devices, the practice of radiation protection, or those who have a desire to institute practices of safety in regard to radiation.

These members should include the areas of Agriculture, Life and Health Sciences, Chemistry, Engineering, Marine Studies, Nursing, Physics, Safety and the Radiation Safety Officer.

The activities of the committee are directed by the chairperson, who is appointed by the Provost or Associate Provost for Research upon recommendation of the committee.

The business of the committee is administered through the Radiation Safety Office which is directed by the Radiation Safety Officer. The Radiation Safety Officer is a full-time professional staff member from the Division of Safety, appointed by the Associate Vice President for Personnel and Employee Relations, upon recommendation of the Radiation Safety Committee on the basis of the person's experience, education, and qualifications in the area of radiation safety. The Radiation Safety Officer serves as executive secretary to the Radiation Safety Committee.

Meetings of the committee shall be called by the chairman at his discretion, not less than once per quarter (calendar year) or on petition by any member of the committee.

A quorum of the committee to conduct business shall consist of at least three members plus the Radiation Safety Officer.

The Radiation Safety Officer and the chairman shall conduct the interim business of the committee subject to the approval of the committee at the next scheduled meeting.

1.3. RESPONSIBILITIES OF THE RADIATION SAFETY COMMITTEE

1.3.1. Assume the responsibility for the radiation safety aspects for all University programs involving radioisotopes or radiation producing devices.

1.3.2. Review and grant permission for, or disapprove the use of, radioisotopes in any amount or radiation producing devices within the University from the standpoint of radiation safety. A simple majority of the committee is required for approval.

1.3.3. Review and prescribe special conditions, requirements and restrictions that may be necessary for safe handling or radioisotopes including additional training of personnel and physical examinations (e.g. blood test, urine specimens, etc.) before commencing work with radioisotopes, designation of limited areas of use, proper disposal methods, and procedures to be followed after spills or other radiation accidents. The committee must approve any project involving radioisotopes or radiation producing devices before it can be initiated.

1.3.4. Serve as the University's sole liaison with the Delaware State Board of Health and the United States Atomic Energy Commission in matters of registration, licensing, and radiation safety.

1.3.5. Receive and review periodic and/or urgent reports from the Radiation Safety Officer regarding:

a. Results of area monitoring.

b. Personnel exposures as measured by suitable dosimeters.

c. Accidents in handling, storage or use of radioisotopes.

d. Loss or theft of any amount of radioisotopes.

e. Records of radioisotope procurement and disposal.

1.3.6. Recommend remedial action if safe procedures are not being observed where ionizing radiation hazards exist or if these procedures are not in compliance with government regulations.

1.3.7. Pass judgment in advance of construction of new buildings or remodeling of existing buildings in which the use of radioisotopes or radiation producing devices is contemplated. Written approval is needed from the committee of the proposed building plans.

1.3.8. Keep department chairmen and radioisotope users advised of current rules and recommendations of various government agencies concerned with radiation safety and the safe use of radioisotopes.

1.3.9. Keep a written record of actions taken in approving or disapproving the use of radioisotopes and radiation producing devices and other transactions, communications and reports involved in the work of the committee.

1.4. APPEAL OF COMMITTEE ACTIONS

Actions taken by the University Radiation Safety Committee may be appealed by the staff member or department concerned to the Associate Provost of Research, with the prior knowledge of the Department Chairman and Dean of the College.

2.0. THE RADIATION SAFETY OFFICER

2.1. AUTHORITY OF THE RADIATION SAFETY OFFICER

The Radiation Safety Officer derives his authority from the Vice-President for Employee Relations, Office for Safety Coordination and the Radiation Safety Committee. The Radiation Safety Officer is a member, and the authorized representative, of the Radiation Safety Committee regarding measures to implement radiation protection and control within the University.

The Radiation Safety Officer, or his authorized representative, has the authority to stop all operations with radioisotopes or radiation producing devices where a potential hazard or violation exists. Resumption of operations may take place only upon authorization from the Radiation Safety Committee.

2.2. RESPONSIBILITIES OF THE RADIATION SAFETY OFFICER

The Radiation Safety Officer will have the responsibility for ensuring adherence to all regulations issued by or subscribed to by the Radiation Safety Committee and will advise and assist the Radiation Safety Committee with regard to the current applicable regulations of the United States Atomic Energy Commission, the United States Public Health Services, state and local agencies, and all similar codes and regulations.

2.2.1. Implement the organization, administration and management of the Radiation Safety Program of the University of Delaware.

2.2.2. Interpret regulations which govern the use of sources of ionizing radiation and disseminate information on radiation safety.

2.2.3. Develop and keep up-to-date a manual of Radiation Safety regulations and procedures for the University of Delaware.

2.2.4. Supervise all radiation protection programs and develop and maintain these programs.

2.2.5. Coordinate the dosimetry service, maintain personnel exposure records, and give timely notification of exposures to supervisors as well as individuals exposed.

2.2.6. Review all requests for procurement of radioisotopes to assure compliance with limitations for possession and use.

2.2.7. Procure, receive and arrange delivery and shipment of all radioactive materials coming to or leaving the University.

2.2.8. Maintain records of procurement and receipt of radioactive materials, including non-AEC regulated isotopes and radiation producing devices and machines.

2.2.9. Supervise the radioactive waste disposal program.

2.2.10. Instruct groups of employees on proper procedures for handling radioactive materials.

2.2.11. Maintain radioisotope disposal records and records of transfer of any radiation producing equipment.

2.2.12. Conduct periodic radiation surveys and wipe tests in laboratories and storage areas; leak tests on significant sources.

2.2.13. Conduct alpha scintillation meter surveys when applicable (e.g. radium storage areas) and provide instrumentation for overseeing the decontamination of alpha-contaminated areas or equipment.

2.2.14. Conduct surveys on and register all radiation producing equipment other than those used to calibrate instruments.

2.2.15. Perform leak tests on sealed sources.

2.2.16. Maintain running inventory of radioisotopes, sealed sources, and radiation producing equipment at the University.

2.2.17. Assume the responsibility for storage of sources and materials not in current use.

2.2.18. Assume the responsibility for calibration of monitoring and surveying equipment.

2.2.19. Verify and report to appropriate authorities any radiation incident which may have resulted in injury to, or contamination of, personnel or damage to property.

2.2.20. Note and take steps in order to correct nuclear and radiation safety problems as well as general laboratory safety problems.

2.2.21. Perform other duties related or similar to the type described above.

3.0. UNIVERSITY REGULATIONS GOVERNING THE USE OF RADIOACTIVE MATERIALS

3.1. PROCUREMENT OF RADIOACTIVE MATERIAL

All radioactive materials for all University facilities (including Regional Campuses, Research Farms and other off-campus locations and properties) shall be procured through the Office of the Radiation Safety Officer. This includes the so-called "license exempt" radioactive materials.

An instruction sheet and the Radioactive Material Requisition (Form RSO-1) can be obtained from the Radiation Safety Office. Examples of this form and sheet are included in Appendix A.

3.1.1. APPROVAL OF REQUEST FOR AUTHORIZATION TO USE RADIOACTIVE MATERIALS OR RADIATION PRODUCING DEVICES

Approval of an applicant using the request form (RSO Form APFT) will be granted by the Radiation Safety Committee on the basis of the applicant's experience and training; proposed use, type, and level of material to be used; facility where the material will be used and the personnel involved.

Request forms (RSO Form APFT) can be obtained from the Radiation Safety Officer and should be submitted to the Radiation Safety Officer who will circulate requests to the Radiation Safety Committee. An example of the RSO Form APFT is included in Appendix A.

The procedure for obtaining approval is:

3.1.1.1. Submit RSO Form APFT. (This should normally be submitted by the principal investigator who will be the designated License Permit Supervisor.)

3.1.1.2. Upon receipt of RSO Form APFT, the Radiation Safety Officer will review and evaluate the information given. The information and recommendations of the Radiation Safety Officer are then distributed to the committee. For all approvals whether temporary or permanent, the committee reviews RSO Form APFT using the following parameters:

a. Authorization of Personnel, RSO Form APFT, Pages 1, 2, and 6.

Both the designated License Permit Supervisor and other personnel on the project (users) are classified into the following categories based on their training and experience:

Class A. - Adequate training and extensive experience; has held or could hold specific NRC license.

Class B. - Adequate training and experience.

Class C. - Adequate training and some experience or some training and adequate experience.

Class D. - Some training or experience.

Class E. - No previous training or experience.

1) License Permit Supervisor - is usually a professional staff or faculty member having rank of instructor or above or those individuals deemed qualified by the Radiation Safety Committee. In order to supervise users of a Class D or E category, a License Permit Supervisor must have a Class A or B rank.

   a) A License Permit Supervisor will generally be required to meet a minimum of the following requirements: a college degree at bachelor's level (or equivalent) in science or engineering and at least 40 clock hours of training and experience in safe handling of radioisotopes, the characteristics of ionizing radiation, quantities and units of radiation dose and biological hazards of radiation exposure.

2) Authorized Users - are the other personnel working on a project or with a device as designated on RSO Form APFT. They are usually students (graduate or undergraduate) or employees (post-doctoral fellows, research technicians, etc.). They may be working on the project of the License Permit Supervisor or carrying out independent research for an academic degree under general supervision of the License Permit Supervisor.

3) Other Personnel Specifications -

   a) Persons categorized as Class E users can hold that status only for one (1) month after issuance of a temporary permit under the supervision of a Class A or B License Permit Supervisor.

   b) The License Permit Supervisor (Class A or B) must be present and give direct supervision when a Class E user is handling radioisotopes or radiation devices.

   c) The License Permit Supervisor (Class A or B) shall give instruction to the Class E user not registered for the formal course during his/her month at that status in safe handling of radioisotopes used, rules and regulations of 10 CFR-19, 10 CFR-20 and the University Radiation Safety Manual or request Radiation Safety Office assistance in giving instruction. Also, any other users in categories C and D shall be instructed if specified by Radiation Safety Committee.

   d) Certification that instruction has been given will be sent to the Radiation Safety Officer via the "check-off list" which can be obtained from the Radiation Safety Office. The Radiation Safety Officer will verify instruction through examination.

   e) Upon successful examination the Class E user will be promoted to Class D status allowing the person to handle radioisotopes independent of the License Permit Supervisor's presence, but still under the License Permit Supervisor's general direction.

   f) Persons successfully completing the formal course on Safe Handling of Radioisotopes will be promoted to Class B or C users or can be License Permit Supervisors if approved by the Radiation Safety Committee.

The License Permit Supervisor and other personnel (users) are granted authorization by following the preceding parameters and that the designated License Permit Supervisor's knowledge and ability are commensurate with the project to be carried out, hazards involved, agree to follow all University regulations governing the use of radioactive materials and radiation producing devices, and, upon request of the committee, submit a history of past occupational and medical exposure or any other special medical requirements (e.g. record of recent complete blood test).

b. Authorization of Project RSO Form APFT; Pages 3 and 4

Project for which radioisotopes are requested shall be reviewed by the Radiation Safety Officer and the Radiation Safety Committee for feasibility based on the information given on pages 3 and 4 of RSO Form APFT.

c. Authorization of Facility

Radioactive materials are to be used only in those facilities which have been approved by the Radiation Safety Officer and the Radiation Safety Committee.

Due to size of laboratories, benches or portions of benches within laboratories may be designated as radioisotope use areas and nonuse areas. Use areas must be properly designated with a Radioactive Material sign or tape around the dimensions of the area. The granting of the use - nonuse area designation will be based on the laboratory classification.

1) Laboratories will be classified as Type A (High Level), Type B (Intermediate Level), Type C (Low Level) and Type D (Very Low Level) according to the type and level of material to be used and the type of usage. (See Appendix B, Tables 1-3; General Requirements for each type of laboratory are listed in Appendix B, Table 4.)

2) Monitoring Instruments: Unless specifically exempted by the committee or Radiation Safety Officer, each laboratory in which radioactive materials or radiation producing devices are used shall have on hand or readily available in operating condition a properly calibrated survey or monitoring instrument appropriate to the type and level of ionizing radiation used.

3) Other Radiation Safety Equipment: The Radiation Safety Committee may require the use of other special equipment or devices that it may determine to be necessary to ensure the safe use of radioisotopes in a given situation. This includes special shielding, handling tools or tongs, alarms and warning devices, air sampling equipment and other such apparatus.

4) Radioactive waste containers are required as specified in 3.7.

5) Handling and usage of 50 millicurie amounts of H-3 (organic compounds) and millicurie amounts of I-125 and I-313 (non-contained compounds) shall be confined in a fume hood having a flow rate of at least 100 linear feet per minute.

3.1.1.3. ISSUANCE OF AUTHORIZED PERMIT

If there are no objections within ten days by the Radiation Safety Committee Members to the information given on RSO Form APFT and the Radiation Safety Officer's recomendations distributed, a temporary permit and number are issued by the Radiation Safety Officer. This temporary permit has a number which will be used on all radioisotope requests. A permanent permit "Authorization Permit for Use of Radioisotopes and Radiation Producing Devices" (RSO Form LP) is issued after review and final approval at the quarterly or special meeting of the full committee. The temporary number will be changed to a permanent one at that time.

3.1.1.4. AMENDMENT(S) TO AUTHORIZED PERMITS

Amendments will be granted on the same basis as original requests for authorization but only the pages of RSO Form APFT concerned with the change need be submitted.

a. Examples of pages to fill out if change applies to:

1) New isotopes, same project: Pages 1 - 2

2) Initial isotopes requested, different project: Pages 3 - 4

3) Change in facility location of usage: Page 5

4) Same isotopes, project and facility, new personnel: Page 6

3.1.1.5. RENEWAL OF AUTHORIZATION

Authorizations will be granted for one (1) year. One month before the expiration date the permit holder is requested to submit pages 1 and 2 of RSO Form APFT and any of the other pages needed if amendments to the original application are involved.

3.2. RESPONSIBILITIES OF LICENSE PERMIT SUPERVISOR

Those persons who have been issued permits by the Radiation Safety Committee to use radioisotopes are responsible for the safe use of radioisotopes and radiation sources by individuals under their supervision. They are also responsible for:

a. Compliance with University regulations for safe handling of radioactive materials and NRC regulations 10-CFR-19 and 10-CFR-20.

b. Instruction of students and employees under their supervision in the use of safety devices and procedures (e.g., wearing of film badges, surveying hands and clothing, submit urine or blood samples as required by committee, etc.). To instruct Class E users during the one month duration as outlined in section 3.1.1.2. 3) a) through f), and instruct all users in rules and regulations outlined in point a of this section.

c. Proper planning of an experiment or procedure to ensure that adequate safety precautions are observed.

d. Communication to the Radiation Safety Officer of all pertinent information regarding changes in their permits. (e.g., employee, operational and procedures changes, alteration of physical plant, etc.)

e. Limiting the use of radioisotopes under their permits to authorized users.

f. Maintaining required records of receipts, use, storage and disposal of radioisotopes.

g. Preparing an inventory of radioisotopes on hand every May.

h. Maintain security of radioisotopes in use and in storage.

i. Receive instruction in radiation safety as determined by the Radiation Safety Officer.

3.3. RESPONSIBILITIES OF ALL USERS

Each person who has contact with radioisotopes has a responsibility to:

a. Refrain from smoking, eating, drinking, food preparing and applying cosmetics in radioisotope laboratories.

b. Survey hands, shoes, body and clothing for radioactivity and remove all contamination before leaving the laboratory.

c. Check work areas periodically for contamination and keep a written record of results. Periodically means experiments involving use of radioisotopes continuously over a period of time - survey for contamination daily. Experiments involving irregular use of radioisotopes at irregular intervals - survey for contamination on day of initial use and daily while use continues.

Written record of results will be inspected by the Radiation Safety Office.

d. Conduct decontamination procedures when necessary.

e. Report immediately to the Radiation Safety Officer the details of spills or other accidents involving radioactivity.

f. Wear the recommended personnel radiation detectors such as film badges and/or pocket ionization dosimeters and/or thermoluminescent dosimeters (TLD).

g. Use all recommended protective measures such as protective clothing, respiratory protection, remote pipetting devices, ventilated and shielded glove boxes and hoods.

h. Keep personal exposure to radiation at the lowest possible level specifically below the maximum permissible does (mpd) levels as stated in 10-CFR-20.101.

i. Maintain good housekeeping practices in the laboratories.

j. Label radiation equipment and segregate radioactive waste and equipment to avoid cross contamination.

k. Maintain security of radioisotopes in use and in storage.

3.4. CLASSIFICATION OF AREAS

3.4.1. UNRESTRICTED AREAS

An area is unrestricted and does not require control measures if:

a. An individual, continually present in the area, cannot receive more than 2 mRem in any one (1) hour, or one hundred (100) mRem in any seven consecutive days, to any portion of the body.

b. When allowance is made for expected occupancy and time variations in dose rate, no individual is likely to receive more than 500 mRem in a calendar year.

3.4.2. RESTRICTED AREAS

a. All areas within the University in which dose levels do not conform to the standards for unrestricted areas shall be restricted and shall be under control of the Radiation Safety Officer for radiation safety purposes.

b. A caution sign - CAUTION RADIATION AREA - shall be prominently displayed at the entrance to each restricted area and the individual who has been issued a license permit for work with radioisotopes in each such area shall be responsible for controlling access to this area.

3.4.2.1. POSTING OF AREAS AND OTHER LABELING REQUIREMENTS

Signs are required by law to denote areas or containers with levels of radiation or radioactivity specified in the following sections.

a. CAUTION RADIATION AREA - Any area accessible to individuals in which there exists ionizing radiation at such levels that a major portion of the body of such individuals could receive an absorbed dose greater than 100 mRem in any five consecutive days.

b. CAUTION HIGH RADIATION AREA - Any area accessible to individuals in which there exists ionizing radiation at such levels that a major portion of the body could receive an absorbed dose greater than 100 mRem in one hour.

c. CAUTION RADIOACTIVE MATERIALS - Although federal regulations exempt certain containers, rooms, etc., containing radioactive materials less than amounts specified as per 10-CFR-20.203 (e), (f) and 10-CFR-20 Appendix C, for the purposes of this manual , all containers, rooms, refrigerators, etc., containing any radioactive materials should have a Caution Radioactive Materials sign, also indication of isotope and amount when necessary, in order that all persons are aware of the presence of radioactive materials.

d. Only signs of the design specified in 10-CFR-20 shall be used.

3.5. PROCEDURES FOR USING RADIOACTIVE MATERIALS

3.5.1. UNSEALED SOURCES

3.5.1.1. PROTECTIVE RULES FOR PREVENTING PERSONAL CONTAMINATION

Extreme personal cleanliness and careful techniques are the primary means of preventing contamination and protecting against ingestion of radioactive materials. In order to minimize contamination and prevent entrance of radioactive materials. into the body, the following rules shall be observed in laboratories where unsealed sources are used.

a. Eating, drinking, food preparation, food storage, application of cosmetics and smoking shall not be permitted in laboratories where radioactive materials are stored or used.

b. Storage of food and beverages is not permitted in the same storage location (refrigerator, etc.) as radioactive materials.

c. The use of milk bottles or other food containers for handling or storing radioactive materials is forbidden.

d. Pipetting of radioactive solutions by mouth shall not be permitted. Remote devices are available and shall be used for such applications.

e. No experiments with radioisotopes should be undertaken until trial runs, complete in every detail, are made with nonradioactive materials. Such runs should be made until the procedure is reproducible, and improvements incorporated as needed.

f. Any work with materials susceptible to atmospheric distribution (e.g. vaporizing, spillage, dusting, effervescence of solution, or other releases of radioactive gas) shall be confined in a suitable hood or glove box.

g. Personnel shall not be permitted to work with radioisotopes if there are open cuts or abrasions on the body. Extreme precaution must be taken to avoid cuts or puncture wounds, especially when working with materials of high activity or of a high hazard.

h. Care must be exercised when using organic solvents to avoid skin contact with radioactive materials. (Solvents may make the skin more permeable.) Appropriate gloves should be worn for handling radioisotopes.

i. Monitoring of hands, feet and clothing is recommended especially where large amounts of radioactive materials are being used. Protective garments should be left in the laboratory when work is completed or until monitored and found free of contamination.

3.5.1.2. PROTECTIVE RULES FOR CONTROLLING CONTAMINATION OF LABORATORY FACILITIES AND EQUIPMENT

a. Auxiliary containers, blotters, and covers shall always be used where danger of spills and contamination of the person or equipment is possible.

b. Contaminated equipment, or equipment that has been used and is suspected of contamination, shall be isolated in designated areas in the laboratory or in suitable storage spaces.

c. Tools, equipment and apparatus when used in handling radioactive material, should be placed in non-porous metal trays or pans which are lined with absorbent disposable paper. This paper should be monitored and changed frequently.

d. Care should be taken that equipment, not immediately necessary to the operations being performed, is not brought into the working area.

e. Equipment and tools shall be routinely monitored following their use. No equipment shall be returned to stock unless it is known to be completely free of contamination inside and out.

f. Contamination shall not be allowed to remain on working surfaces or floor unless appropriately shielded. (For purposes of this rule contamination is taken to mean amounts of beta-gamma activity greater than 100 dpm or alpha activity greater than 20 dpm as determined by standard smear test on a surface of 100 cm^2.)

3.5.2. SEALED SOURCES

3.5.2.1. DEFINITION

A sealed source is one in which radioactive material is permanently encapsulated (in stainless steel, plastic, glass, lacquer or other material) to prevent leakage, and in which the intent is to utilize the radiation emitted rather than the material itself.

3.5.2.2. HANDLING PRECAUTIONS

a. Sealed sources should not be handled directly with the hands. The use of remote handling tools for sources of high activity is essential to minimize both whole body and hand exposure.

b. Users of sealed sources should monitor themselves routinely during periods of work with the sources to assure that source rupture or leakage has not occurred.

c. Under no circumstances should a user attempt to repair a ruptured or leaking source.

d. In case of devices containing sealed sources, users may use the device only as recommended by the manufacturer. Sources may not be removed from such devices except in those cases where the devices are specifically designed for usage of the source outside of the device.

e. Repair of devices containing radioactive sources is normally not permitted when such repair involves those parts of the device containing the source. The Radiation Safety Officer should be consulted to determine the conditions under which minor repairs or corrections may be authorized.

3.5.2.3. LEAK TESTING

Unless otherwise exempted by A.E.C. regulations because of low activity, periodic leak tests are required on all sealed sources.

a. Such tests will be carried out at intervals not to exceed six months (preferably every three months), except in cases where the A.E.C. has specified otherwise.

b. Such leak tests, as are required, will be performed by the Radiation Safety Officer or his authorized representative. Users are required to make their sealed sources available for such tests at the necessary intervals.

c. Whenever leak tests reveal the presence of 0.005 microcuries or more of removable contamination on a sealed source, the source must be immediately removed from further use and steps must be taken to prevent and control the spread of contamination.

d. Leaking sources must either be disposed of as radioactive waste or returned to the manufacturer for repairs.

3.5.2.4. CAUTION SIGNS, LABELS AND TAGS FOR SEALED SOURCES

a. Any sealed source containing by-product material (as defined by A.E.C.) which is used outside of its shielded container shall be labeled with an attached tag not less than one square inch in size bearing the radiation symbol and words "Caution Radioactive Material -- Do Not Handle -- Notify Civil Authorities if Found." Colors shall be magenta and yellow.

b. Sealed sources mounted in devices or shields shall be tagged on the device or shield with Caution Radioactive Material. Also the nuclide and date of assay shall be included. Colors shall be magenta and yellow.

3.6. TRANSFER OF RADIOACTIVE MATERIALS

3.6.1. ON-CAMPUS TRANSFERS

3.6.1.1. Radioactive materials shall not be transferred from one department or laboratory to another without approval by the Radiation Safety Officer, since approval for the use of the materials is given only for the original working area.

3.6.1.2. All transfers between laboratories, or from storage areas to working areas, shall be done in such a manner as to minimize the probability of spillage or breakage. Double containers should be used, including suitable shielding, for such transfers.

3.6.2. OFF-CAMPUS TRANSFERS

3.4.2.1. Radioactive material shall not be shipped or transferred to or from the University without approval of the Radiation Safety Officer. Approved shipments must be packaged and labeled in accordance with D.O.T. regulations, the A.E.C. regulations or the U.S. Postal regulations, whichever is applicable.

3.7. DISPOSAL OF RADIOACTIVE WASTE

3.7.1. GENERAL CONSIDERATIONS

3.7.1.1. Except as specifically authorized by the Radiation Safety Committee, no radioactive materials shall be disposed of directly into the sanitary sewage system, into the atmosphere, or into cold trash baskets (non-radioactive waste). All radioactive wastes must be collected by the user in suitable containers for processing and disposal by the Radiation Safety Officer.

3.7.1.2. Any accidental releases of activity into the environment must be reported immediately to the Radiation Safety Officer.

3.7.1.3. When unusual problems of disposal arise, the Radiation Safety Officer must be consulted to establish a satisfactory procedure.

3.7.1.4. The Radiation Safety Officer will collect all dry and liquid radioactive waste periodically.

3.7.1.5. All types of waste should be separated by half-life, short (less than 30 days), and long (more than 30 days).

3.7.2. DRY WASTE

3.7.2.1. CONTAINERS

Waste containers for disposal of dry contaminated wastes are to be available in all laboratories using unsealed radioisotopes. Normally these should be a metal waste container with a step-pedal operated lid and plastic bag liner. Waste cans should be conspicuously labeled with a Caution Radioactive Materials sign.

3.7.2.2. SEGREGATION BY HALF-LIFE

Dry waste, contaminated with short-lived radioactivity (half-life is less than 30 days) should be collected in a separate container from dry waste contaminated with long half-life (greater than 30 days) material.
Normally the short-lived material will be held for 10 half-life periods and then disposed of, according to procedures of the Radiation Safety Officer, as non-radioactive waste.

3.7.2.3. LABELING OF WASTE FOR PICK-UP BY RADIATION SAFETY OFFICER

All dry radioactive waste for pick-up by the Radiation Safety Officer shall be sealed and properly labeled with a standard radioactivity caution label and should bear the following additional information:

a. User's name, department and account code number

b. Isotope(s)

c. Approximate quantity of activity

d. Date

3.7.3. LIQUID WASTE

3.7.3.1. CONTAINERS

Containers for liquid waste should be 5 gallon plastic carboys or 30 gallon liquid drums, filled with solid pak, of the type provided by Teledyne/Isotopes.

3.7.3.2. LABELING OF WASTE FOR PICK-UP BY THE RADIATION SAFETY OFFICER

All liquid containers shall be properly labeled with a Caution Radioactive Material sign. In addition, liquid waste containers shall bear the following additional information:

a. Users' names, department, and account code number

b. Isotope(s)

c. Approximate quantity of activity

d. Date

e. Principle solvents or reagents in container (e.g. water, acid, etc.) including approximate pH.

3.7.3.3. STRONG ACIDS, BASES, OR OTHER SOLVENTS

Unless special arrangements are made with the Radiation Safety Officer, the user is required to neutralize or otherwise dilute strongly acid or basic waste solutions to the point that they

can be reasonably mixed in solidifying or absorbing agents without causing violent chemical reactions or releasing strong fumes and vapors or volatilization of the isotope to gaseous state.

In case of organic solvents, especially those which may be highly volatile or otherwise reactive, appropriate precautions must be noted on the waste containers.

3.7.4. GASEOUS AND AIRBORNE WASTES

In cases where the release of volatile radioactive products or radioactive aerosols are anticipated, means should be provided to trap such materials (either by chemical or physical methods). The resulting product may then be handled as a liquid or dry waste which ever is appropriate.

3.7.5. BIOLOGICAL WASTES

The Radiation Safety Officer should be contacted regarding all problems that may arise in disposal of biological wastes containing radioisotopes.

3.8. PERSONNEL MONITORING

3.8.1. EXTERNAL MONITORING

3.8.1.1. A.E.C. REQUIREMENTS

Any person working with radioactive material under the University's A.E.C. license is required to wear a personnel dosimeter whenever entering a restricted radioisotope area where he may be likely to receive a dose in any calendar quarter in excess of 25 percent of the values stated in 10-CFR-20.101.

Maximum Permissible Dose in Rems/calendar quarter -- 10-CFR-20.101

Whole body, head & trunk active blood-forming organs lens of eyes or gonads	1.25	Rem
Hands, forearms, feet & ankles	18.75	Rem
Skin of whole body	7.5	Rem

3.8.1.2. UNIVERSITY REQUIREMENTS

In addition to the A.E.C. requirements personnel dosimeters are required for University personnel for all the following situations except as specified in part 3.

a. When working with beta emitters of an energy exceeding 0.25 MeV (i.e. excluding ^{3}H, ^{14}C, ^{35}S and ^{45}Ca unless specified by the Radiation Safety Office.)

b. When working with x-ray and gamma emitters of any energy.

c. When working with neutron sources of any type.

d. When working with x-ray producing devices.

e. When working with accelerators or devices used for accelerating charged particles.

3.8.1.3. EXEMPTIONS FROM PERSONNEL MONITORING

Personnel dosimeters may not be required in cases where it has been definitely established by the Radiation Safety Office that external exposure will not exceed the specified limits. Exemptions will depend on the intensity and energy of the radiation and working conditions involved.

3.8.1.4. DOSIMETER INFORMATION

a. The Radiation Safety Office issues film badges to individuals who require them. Individuals must fill out a Request for Personnel Dosimeter form which is available in the Radiation Safety Office.

b. The badge, when required, must be worn at all times when the individual is occupationally exposed. It should be worn in a fashion so as to indicate whole body exposure (breast pocket, collar, or belt) except in the case of ring, wrist or ankle badges.

c. Badges are issued once per month in the case of beta-gamma badges and twice per month in the case of neutron badges.

d. The badge is not to be worn when the individual is undergoing diagnostic or therapeutic radiation exposure.

e. When not in use the badge should be stored in a location away from radiation (above background), excessive heat or moisture.

f. Badges that are not returned to the Radiation Safety Office by noon of the second working day after the badge change date shall be considered LATE. The individual will be charged a late fee of $2.00 for a late badge. Badges that are not returned to the Radiation Safety Office within two weeks after the film badge change date will be considered LOST. The individual will be charged $4.00 for each lost or damaged film badge.

g. If the film badge is lost or damaged, the maximum legal exposure must be entered on the individual's radiation exposure record unless the individual's Report of Missing Dosimeter shows evidence of no possible exposure. Therefore, it will be to the individual's advantage to return "lost badges" that have been found so that his exposure may be determined.

3.8.1.5. RECORDS AND REPORTS

a. Permanent records of film badge exposures are maintained by the Radiation Safety Office. Copies of these reports are

distributed monthly, by department, to all departments having monitored individuals.

b. In cases where individual monthly doses exceed 100 millirem, the Radiation Safety Office will notify the individual through a written Radiation Exposure Report. The individual shall fill out the information requested on the report and return it to the Radiation Safety Office so that recommendations can be made to prevent recurrence of exposure.

c. The Radiation Safety Office will provide an individual, upon written request, a copy of his permanent occupational exposure history. Records of exposure will be forwarded to new employers upon written request of the individual.

3.8.2. INTERNAL MONITORING OF PERSONNEL

3.8.2.1. ROUTINE URINE ANALYSIS

License Permit Supervisors and users qualified to handle and use in an experiment millicurie amounts of H-3 (organic compounds), Iodine-125 and Iodine-131 in noncontained form, alpha emitters or such other materials that the committee may specify are subject to routine urine analysis in accordance with the following parameters:

a. Each person so qualified shall submit a urine sample to the Radiation Safety Officer who will assay the sample. Also, each person shall upon the Radiation Safety Committee's request submit a recent record of a complete blood count and any other medical history necessary including a physical examination. Any previous radiation exposure history must be filed with the Radiation Safety Officer.

b. Any person handling and using in an experiment 50 millicuries of H-3 (organic compounds) or 10 millicuries of Iodine-125 and/or Iodine-131 (noncontained forms) shall notify the Radiation Safety Officer at least 24 hours in advance of such usage and submit a urine sample for bioassay. Within 72 hours after handling and using in an experiment 50 millicuries of H-3 (organic compounds), the person shall again submit a urine sample to the Radiation Safety Officer for bioassay. Such conditions shall apply for Iodine-125 and Iodine-131 (noncontained forms) except that a urine sample will be required after handling and using in an experiment 10 millicuries within 24 to 72 hours.

c. Personnel who will be handling and using in an experiment microcurie amounts which are drawn from stock supplies containing 50 millicuries of H-3 (organic compounds) and 10 millicuries of I-125 or I-131 (noncontained forms) on a continuous basis, shall supply a weekly urine sample to the Radiation Safety Office for bioassay.

d. Personnel using microcurie amounts of H-3 (organic compound) and I-125 and Iodine 131 (noncontained forms) will be requested to submit a urine sample for bioassay before starting and again upon termination of the research project.

E. Personnel using any other materials the committee may specify shall have routine urine analysis at time intervals designated by the Radiation Safety Officer or when gross contamination levels in the laboratory they work in show incidence of improper handling.

3.8.2.2. SPECIAL URINE ANALYSIS

Individuals who are known or suspected to have accidentally swallowed, inhaled, absorbed, or otherwise ingested radioactive materials will be required to submit urine specimens to the Radiation Safety Officer for analysis. The number and frequency of such samples will be established by the Radiation Safety Officer based on type and level of material and condition of intake.

3.8.2.3. ANALYSIS OF OTHER EXCRETA

Depending on the particular radionuclude, its chemical and physical form and the mode of intake, the Radiation Safety Office is authorized to require the submission of other excreta (such as fecal samples, nose wipes, or breath samples) in addition to or in lieu of urine samples.

3.8.2.4. WHOLE BODY COUNTING

In the case of real or suspected intake of gamma emitting nuclides, whole body counting may be required in addition to or in lieu of excreta samples. The Radiation Safety Officer will arrange such procedures.

4.0 RADIATION EMERGENCY PROCEDURES

Emergencies resulting from accidents in isotope laboratories may range from minor spills of radioactivity, involving relatively no personal hazard to major radiation incidents and spills, involving extreme hazards and possible bodily injury. Because of the numerous complicating factors which may arise and because of the wide range and variety of hazards, set rules of emergency procedure cannot be made to cover all possible situations.

In any emergency, however, the primary concern must always be the protection of personnel from radiation hazards. The secondary concern is the confinement of the contamination to the local area of the accident if possible.

The following procedures are regarded as recommendations except those with asterisks (*) which are required.

REMEMBER ALWAYS TO STATE: TYPE OF RADIATION EMERGENCY
YOUR NAME
WHERE EMERGENCY ASSISTANCE IS NEEDED

WHEN CALLING THE RADIATION SAFETY OFFICER OR SECURITY, IF RADIATION SAFETY OFFICER CAN NOT BE REACHED.

4.1. MINOR SPILLS IN UNPROTECTED AREAS INVOLVING NO RADIATION HAZARD TO PERSONNEL (IN ANY AMOUNT)

* a. Notify all other persons in the area immediately.

b. Permit only the minimum number of persons necessary to deal with the spill into the area.

c. Confine the spill immediately.

1) Liquid Spills - Don protective gloves, Drop absorbent paper on spill.

2) Dry Spills - Don protective gloves, Drop dampened absorbent paper on the spill.(1)

* d. Notify the RADIATION SAFETY OFFICER as soon as possible.(2)

* e. Permit no one to resume work in the area until approval of the RADIATION SAFETY OFFICER is secured.

---

(1) Water may be used except when chemical reaction with water would generate an air contaminant. Oil should then be used.

(2) The RADIATION SAFETY OFFICER (or an assistant) may be reached directly by using the emergency call list posted in each radioisotope laboratory. Or, call the Campus Security Office number directly and they will locate assistance.

4.2. MAJOR SPILLS - INVOLVING RADIATION HAZARDS TO PERSONNEL

* a. Notify all other persons in area immediately of hazard.

* b. Request all persons not involved in the spill to vacate the room at once and notify the RADIATION SAFETY OFFICER immediately giving details of spill.(2)

c. Make no immediate attempt to clean up the spill.(3)

d. If spill is on skin, flush thoroughly with water. If the spill is on clothing, discard outer clothing at once.

e. Switch off all fans.

f. Vacate the room and prohibit entrance to contaminated area.

* g. Permit no person to work in area until the approval of the RADIATION SAFETY OFFICER is secured.

h. Under no circumstances should an untrained person attempt to examine or clean up the radioactive material.

4.3. ACCIDENTS - INVOLVING RADIOACTIVE DUSTS, MIST, FUMES, ORGANIC VAPORS AND GASES

* a. Notify all other persons to vacate the room immediately.

b. Hold breath and close all windows and escape valves. Switch off air circulating devices if time permits.

c. Vacate the room.

* d. Notify the RADIATION SAFETY OFFICER at once.(2)

e. Ascertain that all doors giving access to the room are closed and locked. If necessary, post guards to prevent accidental opening of doors.

* f. Do not reenter the room until approval of the RADIATION SAFETY OFFICER is secured.

4.4. INJURIES TO PERSONNEL - INVOLVING RADIATION HAZARD

a. Wash minor wounds immediately (within 15 minutes if possible) under running water while spreading edges of gash. (Note: light tourniquet action to stop venous return but not to restrict arterial flow may be desirable to stimulate bleeding.)

b. Notify the RADIATION SAFETY OFFICER or Security for Special Medical Assistance.

---

(2) The RADIATION SAFETY OFFICER (or an assistant) may be reached directly by using the emergency call list posted in each radioisotope laboratory. Or, call the Campus Security Office number directly and they will locate assistance.

(3) If spill is liquid and hands are protected, right the container.

c. Permit no person involved in a radiation injury to return to work without approval of the RADIATION SAFETY OFFICER.

4.5. OVER-EXPOSURE OR INGESTION

* a. Any person who suspects over-exposure to radiation from any source must report immediately , by phone or in person, to the RADIATION SAFETY OFFICER. (Any exposure in excess or 1.25 Rem whole body delivered in a period of 13 weeks or less is regarded as an over-exposure for purposes of these regulations.)

* b. Any person who swallows, injects, absorbs, or otherwise ingests radioactive materials (excluding normal environmental contaminants and excluding medical diagnosis or therapy) must report the intake immediately to the RADIATION SAFETY OFFICER or Security.

4.6. FIRES - INVOLVING RADIOACTIVITY

* a. Pull fire alarm.

b. Attempt to put out small fires if radiation hazard is not immediately present.

* c. Notify the Security Department.

* d. Notify the RADIATION SAFETY OFFICER.

e. Govern fire fighting or other emergency activities by restrictions of the RADIATION SAFETY OFFICER.

4.7. CALL LIST FOR RADIATION EMERGENCIES

The following notice is posted in each area where radioactive materials or radiation devices are used or stored.

In case of accidents, spills, loss, theft or fire involving radioactive material,call the RADIATION SAFETY OFFICER FIRST. IF NO ANSWER, CALL SECURITY AND THEY WILL FIND ASSISTANCE FOR YOU.

ALWAYS STATE: TYPE OF RADIATION EMERGENCY
YOUR NAME
WHERE RADIATION EMERGENCY HAPPENED

1. Jenny M. Johansen — Extension - 8475 — Home - 737-4874
   Radiation Safety Officer

2. Security — Extension - 2222

APPENDIX A

FORMS FOR RADIOISOTOPE WORK -

RSO Form APFT:

"Request for Authorization to Use Radioactive Materials or Radiation Producing Devices"

"Project Proposal for Use of Radioactive Materials"

"Facility Approval"

"Statement of Training and Experience"

RSO Form LP:

"Authorization Permit for Use of Radioisotopes and Radiation Producing Devices"

Form RSO-1:

"Radioactive Material Requisition"

Personnel Forms:

Request for Personnel Dosimeter

Radiation Exposure Report

Report of Missing Dosimeter

Exposure History Request

Exposure History Release

Instruction Check-off List

Form RSO-2:

"Radiation Exposure Record"

UNIVERSITY OF DELAWARE

RADIATION SAFETY OFFICE
RSO Form - APFT

REQUEST FOR AUTHORIZATION TO USE RADIOACTIVE MATERIALS OR RADIATION PRODUCING DEVICES

-FOR USE BY RADIATION SAFETY COMMITTEE-

Approved ☐ Not Approved ☐ Date _____ User Classification _____

License Permit No. _____ Temporary License Permit No. _____

Renewal ☐ New ☐ Amendment ☐

Remarks _____

_____ _____ Signed for Radiation Safety Committee and Date

1. Name of Applicant _____
(Please Type or Print Clearly)

2. Social Security Number _____

3. Department _____ 3a. Previous Permit or License # _____

4. Radioactive Materials for which approval is requested: (Indicate radioisotope(s), chemical, or physical form(s), Maximum Activity desired; or specify device.)

_____

_____

_____

_____

_____

_____

5. Type of Use: ☐ New Project
☐ Previously approved Project

Fill out project proposal and attach any significant literature for new projects or change in previously approved project.

6. Facility to be used: ☐ Facility approval requested
☐ Previously approved facility

Building _____ Room _____

Attach Facility Approval for all new facilities or changes in previously approved facilities.

7. Participating personnel indicate status (staff or student) - User Classification.*

1. _____
2. _____
3. _____
4. _____
5. _____

Fill out page 6 for each participating person.

*If Primary application; this does not apply. If renewal, insert User Classification.

8. Statement of Request and Agreement:
The applicant named and participating personnel hereby request authorization to work with radioisotopes and/or radiation devices as specified herein and set forth in associated supportive documents which may be attached. These individuals by virtue or their signatures below, signify that they have read and are willing to abide by the University regulations governing the use of radioisotopes and other sources of ionizing radiation. The undersigned agree to comply strictly with the rules and regulations and hereby agree to notify the Radiation Safety Office two weeks before any termination (sabbatical leave, etc.) of personnel in order that radioactive materials may be disposed of, transferred, or stored and that working areas may be surveyed.

Date _____ Signed _____

Date _____ Signed _____

Date _____ Signed _____

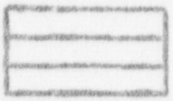
Date _____ Signed _____

Date _____ Signed _____

Date _____ Signed _____

PROJECT PROPOSAL FOR USE OF RADIOACTIVE MATERIALS

Date: _____



New Project
Renewal
Amendment

1. Applicant _____ Department _____ Phone _____

2. Nuclide(s) a._____ b._____ 3. Chemical/physical form(s) a._____ b._____
c._____ d._____ e._____ c._____ d._____ e._____

4. Position of label where applicable a._____ b._____ c._____ d._____
e._____

5a. Amount per experiment (millicuries) _____

5b. Amount per shipment (millicuries) _____

5c. Amount on Hand at any one time (Millicuries) _____

6. Outline the purpose and method of your project. (Give sufficient detail concerning the problem and methods of use of the radioactive material to provide a basis for an evaluation of health hazards and contamination potential.) State frequency of contamination checks which you will record.

7. Identify all procedures (e.g. purification procedure, synthesis plant studies, etc.) which may cause particular problems and evaluate any radiation hazard from (a) the quantity of radioactivity in starting materal, (b) the volatile, liquid and solid wastes, and (c) other contaminated items.

8. Note the instrumentation or methods used to ascertain the radiation level present due to item a,b, and c in question 7. (List make, model, and range for radiation monitors.)

9. Indicate storage conditions for the material, including location and type of contamination. (Specify design thickness and type of shielding material which will be used when applicable)

9. Indicate storage conditions for the material, including location and type of possible contamination. (Specify design thickness and type of shielding material which will be used when applicable)

10. Specify the precautions and procedures that will be taken during your possession of the nuclide to:

(a) Prevent unauthorized removal of radioactive material.

(b) Prevent contamination and excessive levels of radiation in work or adjacent areas.

*If nuclide is to be used in plants or animals please answer item 11 thru 16 inclusive.

11. Plant or animal to be used: _____ 12. Avg. weight of animals: _____

13. Number of plants or animals to be used: _____ 14. Amount of isotope per plant or animal: ___

15. Route of administration: _____

16. Do you anticipate that radioactivity will be contained in the exhaled air? ___Yes ___No; Urine? ___Yes ___No; Feces? ___Yes ___No; Carcass? ___Yes ___No; Roots? ___Yes ___No; Leaves? ___Yes ___No; Stem? ___Yes ___No.

*If any of the above answered yes, please describe in detail the procedures and methods you will employ to control and/or prevent the spread of contamination.

Approval Recommended: _____ Date: _____
University Radiation Safety Officer

Approved: _____
Chairman, Radiation Safety Committee

FACILITY APPROVAL

1. Department _____ 2. Building _____ 3. Room _____

4. Sketch of Facility:

5. Type of flooring: _____

6. Walls and Ceiling: (Paint or coating) _____

7. Bench top material: _____

8. Hood(s) Single ducted? _____Yes _____No: Flow rate ½ sash _____ linear ft/min

9. Number of persons normally working in area: _____

10. Education level of persons in area _____ under-grad/_____grad/_____technician/_____postdoct/ or _____ faculty?
Are other personnel approved radioisotope workers? _____Yes _____No. Is this area also used for study/office area for research personnel? _____

11. Monitoring device in facility: _____Yes _____No. (If yes and haven't listed device in project proposal list make, model, type, range.) _____

_____

_____

_____

12. Special handling facilities (shielding, glove boxes, etc.) _____

_____

13. Staff member in charge of laboratory: _____

14. Individual submitting this request: _____ Date _____

Approved: _____ Date: _____

Radiation Safety Officer

STATEMENT OF TRAINING AND EXPERIENCE

1. Name _____ 2. Social Security No. _____

3. Type of Training (Circle Yes or No in Columns I and II. If "Yes" is indicated in either column, complete items III and IV)

TYPE	FORMAL COURSE	ON THE JOB	WHERE TRAINED	DURATION OF TRAINING
(A) Principles and Practices of Radiation Protection	Circle One Yes No	Circle One Yes No		
(B) Radioactivity Measurement monitoring techniques, and instruments.	Circle One Yes No	Circle One Yes No		
(C) Mathematics and calculations basic to the use and measurement or radioactivity.	Circle One Yes No	Circle One Yes No		
(D) Biological effects of radiation.	Circle One Yes No	Circle One Yes No		

4. Formal Courses (If "Yes" circled in column I for any of items above, complete this item, listing all courses pertaining to use of radiation or radioactive materials, atomic and nuclear structure, radiochemistry, radiation biology, nuclear engineering, etc.)

Title of Course	Where Trained	Course Content
(A)		
(B)		
(C)		
(D)		

5. Experience (List actual use of radioactive materials, details of formal laboratory courses or on the job training.)

Isotope	Maximum Amount	Where experience	Duration	Type of use

6. Was film badging required in experience situations? _____Yes _____No

7. Additional Comments or Remarks:

RSO Form - LP

UNIVERSITY OF DELAWARE

AUTHORIZATION PERMIT FOR USE OF RADIOISOTOPES
AND RADIATION PRODUCING DEVICES

License Permit Number: _____ Licensee: _____

Date issued: _____ Expiration Date: _____

NOTE: License Permit number must be shown on all radioisotope orders in space provided for License Number.

In accordance with statements and representations made in your Request for Authorization to use Radioactive Materials or Radiation Producing Devices, dated _____ approval is hereby granted authorizing the below named individuals to order, possess and use the materials or items designated below in accordance with University regulations and such other conditions as are herein specified.

1. AUTHORIZED USERS:

Name	Department	Status

2. LOCATION(S) OF USE:

Building	Room	Comments

3. AUTHORIZED RADIOISOTOPES OR ITEMS:

Nuclide or Item	Maximum Acitvity Limits		
	Per Experiment	Per Order	Possession(Storage)

4. AUTHORIZED USE:

5. CONDITIONS:

Laboratory Monitors:

Film Badges:

Other Dosimeters:

Caution Signs:

Waste Containers:

Personnel Restrictions:

Special Precautions or Requirements:

Approved: _____ Date: _____

Chairman, Radiation Safety Committee

THIS FORM USED FOR ONLY FOUR FORMS OF SAME NUCLIDE

University of Delaware Form RSO-1	**RADIOACTIVE MATERIAL REQUISITION** Note: Complete a separate requisition for each different Nuclide; retain top sheet and forward remaining form to Radiation Safety Officer at 417 Academy Street.	Control No.:

Department	User	Phone
Project, Account or Grant Number	Licensee	License Number

Quantity (mCi)	Catalog No.	Nuclide and Form	Specific Act.	Est. Price
1.	1.	1.	1.	1.
2.	2.	2.	2.	2.
3.	3.	3.	3.	3.
4.	4.	4.	4.	4.

Total

Vendor Suggested

Dates Desired

Remarks

Requested by

Building

Date of this Request

Approved by (Department head or authorized agent)

Date

- - - - -Do not write below this line- - - - -

Approved by R.S.O.

Date

Comments

(To be completed when order received)

P.O. Number

Date Received

User Notified

☐ A.M.
☐ P.M.

Assay Information	Health Physics Survey	Billing
Quantity (mCi)	Exposure Rate-unshielded	Cost of Nuclides
Conc. (mCi/ml)		Vendor Handling
Vol. or Wt.	Exposure Rate-shielded	Freight, postage, etc.
Sp. Act.		Other charges
Time of Assay	Surface Contamination	
Total Solids	alpha:	
Normality	beta-gamma:	Total
Purity	Other precautions	Date Billed
Lot No.		Billing Prepared by:
Ser. No. (sealed source)		
Other		Journal Voucher No.

Received By:

Date

UNIVERSITY OF DELAWARE RADIATION SAFETY OFFICE

REQUEST FOR PERSONNEL DOSIMETER

Badge No. _____

All of the information requested below is required by the Atomic Energy Commission. If this requisition is not complete, it will be returned. No badge will be issued without a completed requisition.

1. Name _____ 2. Maiden Name _____
   Last, First, Middle (Please Print)

3. Sex _____ 4. Social Security No. _____ 5. Birthday _____
   Month-Day-Year

6. University Location _____ _____
   Department Building

   Course Work _____ Employee _____

7. Status _____
   Faculty, Staff, Student

8. Will you be working with _____ x-rays; _____ radioisotopes; _____ other?

   If other circle one: accelerator ; reactor ; gamma irradiator ; neutron source?

9. Have you previously been associated through employment or course work with an employer or University etc. where you were required to wear a dosimeter (film badge, TLD, pocket ionization chamber,etc.). Do not include any diagnostic or therapeutic radiation exposure. List most recent employer first.

	Employer & Address	Started	Terminated
A.	_____	_____	_____
B.	_____	_____	_____
C.	_____	_____	_____
D.	_____	_____	_____

_____ _____
Signature of Requester Signature of Radiation Safety Officer

UNIVERSITY OF DELAWARE RADIATION SAFETY OFFICE

RADIATION EXPOSURE REPORT

Date _____

It has been reported by the personnel dosimetry service that the dosimeter worn by _____, dosimeter number _____, for _____ has received a total dose of _____ millirems. The dosimetry service additionally reported _____

_____

_____ _____

1) Reason for exposure - check appropriate reason(s):

- ☐ Exposure due to _____ x-rays or _____ radioisotopes.
- ☐ Adequate protection devices not available.
- ☐ Failure to use protection devices.
- ☐ Badge exposed while it was not being worn.
- ☐ Badge partially destroyed by heat, water, light, or time.
- ☐ None of the above, explain below.
- ☐ Unknown.

2) Explain all reasons checked in Item 1.

Recommendation of Radiation Safety Officer to prevent recurrence of exposure:

_____ _____

Signature of Employee Signature of Radiation Safety Officer

UNIVERSITY OF DELAWARE RADIATION SAFETY OFFICE

REPORT OF MISSING DOSIMETER

Date _____

Name _____

Badge # _____

Date of Missing Badge _____

The dosimeter described above has not been returned to the Radiation Safety Office. In order to keep adequate radiation exposure records as required by the Atomic Energy Commission and the State of Delaware, the badge must be returned to the Radiation Safety Office.

If the dosimeter is available, return it with this form to the Radiation Safety Office.

If the dosimeter is not available, answer the following questions and return this form immediately to the Radiation Safety Office.

1) Reason dosimeter was not returned.

2) Type of radiation to which you were exposed during the month in question. If you were working with radionuclides, please list them.

3) Vacations during the month in question. Give dates.

4) Any unusual known radiation exposure during the month in question.

_____
Signature of Dosimeter Wearer

ACTIONS OF THE RADIATION SAFETY OFFICE

Date _____

_____
Signature of Radiation Safety Officer

UNIVERSITY OF DELAWARE
NEWARK, DELAWARE
19711

OFFICE FOR SAFETY COORDINATION
417 ACADEMY STREET
PHONE: 302-738-8475

Radiation Safety Officer

Dear Sir:

_____, Social Security Number _____, birth date _____, has indicated that he/she was associated with your institution in a capacity which required radiation monitoring. This association existed from _____ to _____. We would appreciate receiving a summary of those occupational exposures to add to our records.

Thank you.

Jenny M. Johansen, M.S.
Health Physicist
Radiation Safety Officer
University of Delaware

STATEMENT

Under the provisions of 10 CFR 20.404, I authorize the release of and request that all my radiation exposure records be furnished to the Radiation Safety Office.

_____ _____

Signature Date

UNIVERSITY OF DELAWARE
NEWARK, DELAWARE
19711

OFFICE FOR SAFETY COORDINATION
417 ACADEMY STREET
PHONE: 302-738-8475

Radiation Safety Officer

Dear Sir:

The radiation exposure information you requested on _____, Social Security Number _____, birthday _____, is as follows (readings given in mRem):

Year	Type of Radiation	First Quarter	Second Quarter	Third Quarter	Fourth Quarter	Total for Year

This report is furnished to you under the provisions of the Atomic Energy Commission regulations entitled "Standards for Protection Against Radiation" (10 CFR-Part 20). You should preserve this report for future reference.

Sincerely,

Jenny M. Johansen, M.S.
Health Physicist
Radiation Safety Officer
University of Delaware

R A D I A T I O N S A F E T Y O F F I C E

Instruction Check-off List

This is to certify I have instructed: _____

☐ Graduate Student ☐ Undergraduate Student ☐ Employee

in the proper procedures of handling radioisotopes that he/she will be using;

that this instruction included:

- ☐ Storage areas for radioisotopes in my lab.
- ☐ Areas of my lab where radioisotopes can be used.
- ☐ Type(s) of radiation from isotope(s) used.
- ☐ Energy of radiation from isotope(s).
- ☐ External and internal hazards from isotope(s).
- ☐ Special problems of handling the isotope(s).
- ☐ Review of Federal Regulations 10 CFR-19.12, 19.13.
- ☐ Discussion of Federal Regulations 10 CFR-20.
- ☐ Sections 3 and 4 of University Radiation Safety Manual, pages 5-20 and Appendix.
- ☐ Security measures to be used when using radioisotopes or storing them.

Upon successful completion of examination by the Radiation Safety Office, I request a Class "D" user status for this person.

_____
Permit Supervisor

Return to: Radiation Safety Office, 417 Academy Street within one (1) month of receipt.

Form RSO-2

UNIVERSITY OF DELAWARE
RADIATION EXPOSURE RECORD

BADGE NUMBER	NAME (LAST, FIRST, M.I.)	(MAIDEN NAME)	STATUS	DEPARTMENT

DATE OF BIRTH	SOCIAL SECURITY NO	DATE STARTED	DATE TERMINATED

YEAR	WHOLE BODY GAMMA & X-RAY MREM NEUTRON						BETA OR LOW X-RAY MREM						COMMENTS
	YEARLY QUARTERS				YEARLY TOTAL	Cumulative TOTAL	YEARLY QUARTERS				YEARLY TOTAL	Cumulative TOTAL	
	1st	2nd	3rd	4th			1st	2nd	3rd	4th			
Prev. Exp.													

PREVIOUS RADIATION EXPOSURE

PERIOD COVERED
NATURE OF WORK
EMPLOYER
ADDRESS
TOTAL EXPOSURE (MREM) — Gamma & x B

PERIOD COVERED
NATURE OF WORK
EMPLOYER
ADDRESS
TOTAL EXPOSURE (MREM) — Gamma & x B

PERIOD COVERED
NATURE OF WORK
EMPLOYER
ADDRESS
TOTAL EXPOSURE (MREM) — Gamma & x B

PERIOD COVERED
NATURE OF WORK
EMPLOYER
ADDRESS
TOTAL EXPOSURE (MREM) — Gamma & x B

PERIOD COVERED
NATURE OF WORK
EMPLOYER
ADDRESS
TOTAL EXPOSURE (MREM) — Gamma & x B

PERIOD COVERED
NATURE OF WORK
EMPLOYER
ADDRESS
TOTAL EXPOSURE (MREM) — Gamma & x B

COMMENTS

APPENDIX B

EXPLANATIONS OF TABLES I, II, III AND IV

Laboratories are classified based on three factors: (1) radiotoxicity hazard of nuclides in use; (2) maximum amounts of activity stored or used in the area; and (3) type of use in terms of relative hazard of the handling procedures.

In Table I, radioisotopes are classified as to their relative radiotoxic hazard in relation to internal dose. The hazard of a radioisotope depends on the effective half-life of the nuclide in the body or organ, the type and energy of the emitted radiation, the physical and chemical form of the material, and the organ of maximum concentration.

For normal usage, laboratories are classified according to the total activity of the various classes of nuclides present in the lab. Table II gives the four laboratory classifications (high, intermediate, low, and very low) based on the hazard group and activity present. In cases of more than one nuclide in use in a laboratory,the classification will be determined by a summing of the constituent nuclides.

The amount of nuclide permitted in a given class laboratory may be increased or decreased according to type of usage. With high accident risk operations, the amount permitted within the classification is decreased. For simple, relatively safe operations, the amount in a given classification may be increased. As a guide, the modifying factors in Table III are used to determine the amount by which the permitted activity should be increased or decreased.

The Radiation Safety Committee does not have rigid specifications on design requirements for various classes or radioisotope laboratories. As guidelines, however, the design criteria set forth in Table IV may be used. In designing new areas the researcher should consult the Radiation Safety Officer to discuss requirements for a particular facility.

EXPLANATION OF TABLE V

As per section 3.7.1.1., specific authorizations can be given for disposal of waste via sanitary sewer. In Table V, the federal guidelines are stated to insure that,based on the University water flow rate, concentrations of trace amounts or radioactivity released to the sanitary sewer under a specific authorization from the Radiation Safety Committee would not exceed the guidelines as stated in 10-CFR-20.

APPENDIX B

Table I
Suggested Radioisotope Classification (Unsealed Sources)

Class	Description	Examples*
I	Very High Hazard	Sr-90, Po-210, Pu-239
II	High Hazard	Ca-45, I-131
III	Moderate Hazard	P-32, S-35, Co-60, Rb-86, Cs-137
IV	Low Hazard	H-3, C-14

* Radiation Safety Officer has a more complete list of examples.

Table II
Suggested Laboratory Classification (Considering Table IV & I)

Radioisotope Class	Lab Grade			
	A (High)	B (Inter)	C (Low)	D (Very Low)
I	1 mCi	up to 1 mCi	up to 10 uCi	up to 0.1 uCi
II	10 mCi	10 mCi	100 uCi	1 uCi
III	100 mCi	100 mCi	1 mCi	10 uCi
IV	1000 mCi	1000 mCi	10 mCi	100 uCi

Table III
Modification Factors for Laboratory Classification (Table II)

Use	Factor
Storage Only	X 100
Simple Wet Operation (e.g. preparing stock solutions)	X 10
Normal Chemical Operation (e.g. analysis)	X 1
Complex Chemical Operation with High Risk of Spill	X 0.1
Simple Dry Operations (e.g. work with volatile compounds)	X 0.1
Dry Dusty Operations (e.g. grinding)	X 0.01

TABLE IV

SUGGESTED GENERAL DESIGN SPECIFICATIONS FOR LABORATORIES USING RADIOISOTOPES

	Lab Classification			
	A	B	C	D
Floor	Smooth, non-porous Easily removable Protective underlayer No cracks	Same as A	Smooth non-absorbent	Any
Walls	Smooth, non-porous Strippable if possible	Same as A	Painted; smooth	Any
Work Benches	Smooth, nonabsorbent Removable covering (as absorbent paper)	Same as A	Smooth sealed coating - Cover with absorbent paper.	Any - cover with absorbent paper
Ventillation	No recirculated air Absolute filters in exhaust Air room under net negative pressure	Room under net negative pressure-Absolute filter recommended	Room under net negative pressure.	Any
Hoods	Singularly ducted Absolute filter Flow rate: 100 + linear feet per minute	Same as A	Singularly ducted Filters optional Flow rate: 100 linear feet per minute	Any
Other	Consider: Build in shields Special Handling Devices Glove Boxes	Same as A	Portable, localized shielding as needed	

Detailed considerations found in:

1. NBS Handbook 92 "Safe Handling of Radioactive Materials," United States Government Printing Office, Washington (1964).

APPENDIX B

TABLE V

Factors for granting authorization to dispose of radioactive materials via sanitary sewer

As per A.E.C. regulations: No licensed material shall be discharged into sanitary sewerage unless it is:

1) Soluble

2) If diluted by water flow rate to sewer, concentration of material does not exceed that stated in Appendix B, Table I, Column 2 of 10-CFR-20 or;

3) Ten times the quantity of material stated in Appendix C or;

4) GROSS QUANTITY OF ALL LICENSED MATERIAL RELEASED TO SEWERAGE DOES NOT EXCEED 1.0 CURIE PER YEAR.

University water flow rates from July 16, 1973 to July 15, 1974 equaled 31,094,030 ft^3/year.

Equaled 85,189.12 ft^3/day/90 buildings divided by 3.53×10^{-5} ft^3/ml = 26,813,000 ml/day/building.

Example of Soluble Material	Appendix B	Appendix C
3-Hydrogen	1×10^{-1}uCi/ml	1,000uCi
14-Carbon	2×10^{-2}uCi/ml	100uCi
35-Sulfur	2×10^{-3}uCi/ml	100uCi
32-Phosphorus	5×10^{-4}uCi/ml	10uCi
109-Cadmium	5×10^{-3}uCi/ml	10uCi

REFERENCES

1. LICENSING GUIDE FOR TYPE A LICENSES OF BROAD SCOPE FOR RESEARCH AND DEVELOPMENT. U. S. Atomic Energy Commission, Directorate of Licensing Materials Branch, Washington, D.C.-February, 1973.

2. RULES AND REGULATIONS - TITLE 10, CHAPTER 1, CODE OF FEDERAL REGULATIONS, Part 20, 30, 31 and 33. U. S. Atomic Energy Commission.

3. NBS HANDBOOK #73. "Protection Against Radiation From Sealed Sources" - July, 1960.

4. NBS HANDBOOK #53. "Recommendations for the Disposal of Carbon-14 Wastes"- January, 1957.

5. NBS HANDBOOK #48. "Control and Removal of Radioactive Contamination in Laboratories" - January, 1957.

6. NCRP REPORT NO. 39. "Basic Radiation Protection Criteria," January, 1971.

7. "RADIATION SAFETY MANUALS" Auburn University - April, 1972. Harvard University - June, 1972. New England Deaconess Hospital - 1973. Peter Bent Brigham Hospital -January, 1969. Iowa State University - March, 1969. North Dakota State University - April, 1962. Ohio State University - 1967. Purdue University - January, 1972.

8. NBS HANDBOOK #92. "Safe Handling of Radioactive Materials" - March, 1964.