RADIATION SAFETY OFFICE
UNIVERSITY OF MARYLAND

RADIATION SAFETY MANUAL
UNIVERSITY OF MARYLAND
College Park, Maryland

Revised May 2001

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FOREWORD

This manual spells out the requirements of the University of Maryland Radiation Protection Program, and with additional procedures and directives, is a guide to the regulatory requirements governing the use of radioactive materials and radiation producing devices at the University of Maryland Campus and satellite facilities. All personnel using radioactive sources are expected to be familiar with and abide by these requirements. Failure to comply could jeopardize the user's safety and that of others, as well as the authorization to use radioactive materials or radiation producing devices on the Campus and areas off campus under UMD administrative control. The University license is subject to periodic audit by the State of Maryland, Department of the Environment, and US Nuclear Regulatory Commission, NRC, to ensure compliance with the requirements of this manual and the conditions of our radioactive material licenses. The Radiation Safety Committee reviews the Program on an annual basis to ensure effective operation and compliance with both State and Federal regulations. This review is documented in the Radiation Safety Committee Minutes. Failure to comply with the requirements in this manual may result in a suspension of a users authorization and/or loss of the University license.

1. ADMINISTRATIVE ORGANIZATION

1.1 PRESIDENT

The President delegates authority in matters pertaining to campus radiation safety to the Office of the Vice President of Academic Affairs and Provost. This office:

1. Assumes institutional responsibility through the Radiation Safety Officer and the Radiation Safety Committee (RSC) for general radiation safety practices and their administration.

2. Works with, Deans, Directors, and Department Chairpersons, through the Radiation Safety Officer, in establishing a program that provides for the safety of all personnel associated with laboratories using radioactive materials and/or radiation producing devices and meets the State of Maryland licensing/registration requirements.

3. Appoints the RSC and delegates appropriate authority to that body in matters pertaining to radiation safety.

1.2 RADIATION SAFETY COMMITTEE (RSC)

This Section is being revised

1.3 DEANS, DIRECTORS, AND DEPARTMENT CHAIRPERSONS

Deans, Directors, and Department Chairpersons are responsible, within their areas of concern, for following administrative functions:

1. Promoting the safety policies of the Office of the Vice President of Academic Affairs as formulated by the RSC, State of Maryland and/or Federal agencies.

2. Holding faculty members or supervisors responsible for the implementation and enforcement of applicable safety procedures and safety requirements.

3. Authorizing necessary expenditures for safety.

1.4 RADIATION SAFETY OFFICE (RSO)

The RSO functions under the direction of the Radiation Safety Officer, and the Director of Environmental Safety, Sustainability and Risk (ESSR) and provides services to the RSC, College Park Campus & Satellite Facilities. The RSO is responsible for:

1. Advising the Director of ESSR and theOffice of the Vice President of Academic Affairs on the control of radiation hazards.

2. Directing all radiation safety activities on the UMD Campus and satellite facilities.

3. Controlling all radioactive material and radiation producing devices.

4. Acting as executive agent for all State of Maryland licenses for the possession, use, storage, and disposal of radioactive material and radiation producing devices on the Campus and its satellite facilities.

5. Providing advice, assistance, technical support, and supervision to all activities using radioactive material or radiation producing devices on matters of radiation safety.

6. Conducting and administering education and training programs in the safe use of radioactive materials, sources, and radiation producing devices.

7. General surveillance of all radiation safety activities, including both personnel and environmental monitoring.

8. Ordering (or authorize ordering), receiving, processing, and shipping all radioactive materials coming to or leaving the University of Maryland Campus and satellite facilities.

9. Ensuring calibration (as required) of portable survey instruments in a timely manner.

10. Distributing and processing of personnel monitoring devices, including the maintenance of records of internal and external exposure to personnel, and notifying individuals and their supervisors of unusual exposures or when approaching maximum permissible amounts of exposure and assist them in keeping future exposure As Low As Reasonably Achievable (ALARA).

11. Maintaining an around-the-clock emergency response capability to meet any emergency involving radiation, radioactive material, or personnel exposure.

1.5 RADIATION SAFETY OFFICER

The University of Maryland License requires that an individual function as the Radiation Safety Officer. The MD-33-004-01 license condition states that the Radiation Program shall be under the supervision of this individual. The Radiation Safety Officer reports to the Director of Environmental Safety, Sustainability and Risk and is responsible to the President of the University through the Office of the Vice President of Academic Affairs and Provost and the Radiation Safety Committee.

1.6 RADIOACTIVE MATERIAL AND RADIATION EQUIPMENT USERS

1.6.1 PRINCIPAL INVESTIGATOR

The Principal Investigator (PI) is the person to whom the authorization is issued. This individual is responsible for the particular program stated in his/her Authorization for Possession and Use of Radioactive Materials or Possession and Use of Radiation Producing Devices. The principal user's responsibilities are:

1. Planning and organizing an experiment or program keeping in mind the type and amount of radiation or radioactive material to be used and/or produced.

2. **Instructing those personnel, for whom they are responsible, and who will be working under their Authorization, in the use of safe techniques, operation of equipment, and in the application of approved radiation safety practices.**

3. Furnishing the RSO with information concerning individuals and activities in their areas; particularly, pertinent changes in personnel and procedures.

4. Contacting the RSO whenever major changes in operational procedures, rooms locations, alterations to labs (e.g., shielding changes, removal or installation of radioactive material handling equipment) occur or when new operations which might lead to personnel exposure are anticipated.

5. Ensuring that all regulations governing the use of radioactive materials or radiation producing devices are complied with as established by the RSC, NRC, and the State of Maryland.

6. **Equipping each laboratory complex with survey meters capable of detecting the types of radiation that might be encountered in the area.** Ensure that the survey meters are in current calibration and deliver the instrument to the RSO if in need of repair or calibration.

7. Posting all areas under their control with proper radiation warning signs.

8. Ensuring that the personnel under their control discharge their individual responsibilities as listed in Section 1.6.4.

9. Ensuring that all necessary engineering controls are properly in place for use by personnel under their Authorization.

1.6.2 AUTHORIZED USER

An authorized user is a person who is designated this category on the Principal Investigator's Authorization. The authorized user is responsible to the Principal Investigator for all actions listed below for radioactive material or equipment use. This user may work with isotopes or equipment **without immediate supervision**, and may assume limited responsibilities as defined by the Principle Investigator.

1.6.3 INDIVIDUAL USER

An individual user is a person who is designated this category on the Principal Investigator's Authorization. The individual user is responsible to the Principal Investigator for all actions listed below for radioactive material or equipment use. The individual user **must work under supervision** of the Principle Investigator or an Authorized User designated by the Principal Investigator.

1.6.4 RESPONSIBILITIES OF USERS

The responsibility for safe handling of radioactive materials, sources and radiation producing devices rests with all designated users. The following minimum requirements shall be met: (See also Section 3.8.1)

1. Keep exposure to radiation As Low As Reasonably Achievable (ALARA).

2. Wear the prescribed dosimeter such as a whole body badge, TLD, and/or pocket dosimeter while working with radioactive materials, radiation producing devices, or in a radiation area. Personnel who work with only pure alpha emitters and RSO designated low energy beta and gamma emitters will not be required to wear badges. Dosimetry equipment must not be tampered with and must be protected from damage or abuse.

3. Use appropriate protective measures such as:

    a. Wear protective clothing whenever contamination is possible and remove this clothing before leaving the restricted area in which it was used.

    b. Use protective barriers and shields whenever required and appropriate.

    c. Use remote handling tools such as forceps, tongs and pipettes to minimize personnel exposure, where applicable.

    d. Use an approved hood or glove box while using or creating radioactive gases or volatile materials, such as welding on radioactive materials.

    e. Cover work surfaces with absorbent paper and when using liquids, use a plastic underlining. The cover should be changed frequently.

    f. Use stainless steel or disposable fiberglass trays lined with absorbent paper to confine contaminating materials and to limit or collect spillage in case of an accident.

    g. Refrain from eating, drinking, smoking, chewing gum or tobacco, or applying cosmetics in a radiation area or where radioactive materials are used or stored. Storing or preparing food or drink in any area or equipment that is or has been used for radioactive materials, e.g., refrigerator, cabinets, glassware, is prohibited.

    h. Keep cleaning equipment (brooms, mops, buffers, buckets, etc.) used in radiation designated spaces from being used in other areas.

4. Mark and label all radioactive contaminated or potentially contaminated containers and equipment with radioactive marking tape and/or labels as required.

5. Wash the hands (including under the fingernails) thoroughly and survey the hands, shoes and body for radioactive contamination. Remove all loose contamination before leaving the work area/laboratory.

6. Utilize the proper radioactive waste procedures as set forth in Section 3.9.

7. Maintain a log of all meter and wipe surveys conducted by the user. The frequency of survey is dependent on the operation and/or radioactive isotope(s) in use. See Section 3.8. The RSO is available to help establish the survey and record keeping necessary to comply with the licensing requirements.

8. Carry out decontamination procedures when necessary and take the necessary steps to prevent the spread of contamination to other areas.

9. Report accidental inhalation, ingestion, or injury involving radioactive materials to the user's supervisor and RSO. Cooperate with the RSO to evaluate possible exposure if necessary.

10. Know the type of material being used and clearly label all radioactive substances as radioactive with the isotope and activity. Appropriate labels are available from the RSO.

11. Keep the laboratory neat and clean. The work area should be free from equipment and material not required for the immediate procedure.

12. Assure that freezer or refrigeration equipment (spark proof if required) is available for the preservation of radioactive solutions which decompose at normal room temperatures, and for storage of contaminated animal carcasses, plants, or other unstable material awaiting disposal.

13. Eliminate all unnecessary sharp objects from areas where radioactive material is used.

14. Do not handle the telephone, reports, etc., with contaminated hands or while using protective gloves.

2. RADIATION EXPOSURE CONTROL

2.1 ALARA

The radiation protection standards set forth in this section are used to control radiation exposure to all occupationally exposed personnel and non-occupationally exposed personnel. It is the policy of University of Maryland Campus to keep this exposure As Low As Reasonably Achievable (ALARA).

2.2 RADIATION PROTECTION STANDARDS

No individual may receive in one calendar year a total occupational exposure in excess of the following:

2.2.1 OCCUPATIONAL DOSE LIMITS

Exposed Area	REM/yr	Sieverts/yr
Whole body . head and trunk; gonads; arms above elbow, legs above the knee	5.0	0.05
Extremities . hands and fore. arms; feet and ankles, leg below the knee	50.0	0.5
Skin	50.0	0.5
Lens of eyes	15.0	0.15
Any Individual **Organ or Tissue**	50.0	0.5
Embryo/Fetus (Entire Period)	0.5	0.005

The difference between whole body and skin of whole body is determined by the penetrating power of the incident radiation. If the whole body is exposed to radiation with a half value layer of less than 1 mm of soft tissue, then this is considered a skin dose. The dose to the extremities is radiation of any energy.

2.2.2 INTERNAL EXPOSURE

Internal exposure may occur due to inhalation, ingestion or absorption through the skin. The limit to any organ or tissue is 50 Rem/yr (0.5 Sv/yr.) In all cases where the possibility of an airborne hazard exists, every operation will be closely monitored by the RSO with appropriate monitoring equipment.

Protective equipment as required will be worn throughout all such operations and all such experiments will be performed in a hood or glove box when deemed prudent. Appropriate monitoring equipment will be determined at that time with consideration given to the isotope, activity, location and experiment. The RSO has a variety of meters, detectors and air sampling equipment that may be used in such instances.

NOTE: The occupational limits are a summation of external and internal dose equivalents where applicable.

2.2.3 OCCUPATIONAL DOSE TO FERTILE WOMEN

The need to minimize exposure to the embryo/fetus is paramount. It is the policy of the University of Maryland Campus that every effort be made to keep the radiation exposure of the embryo/fetus to the very lowest practicable level during the entire gestation period. Exposure limits for fertile women are the same as for men. Once a pregnancy is declared by a woman, exposure will be evaluated, and the total exposure to the embryo/fetus will be limited to 0.5 rem for the total gestation period. If 0.45 rem exposure to the woman has been reached (at declaration time), the remaining exposure will be limited to 0.05 rem during the remainder of pregnancy.

2.2.4 OCCUPATIONAL DOSE LIMITS TO MINORS

The occupational dose limit to individuals under the age of 18 is 10% of the limits listed above. No individual under 18 years of age shall be employed where he/she could, under normal conditions, exceed this limit.

2.2.5 DOSE LIMITS FOR NON-OCCUPATIONALLY EXPOSED PERSONNEL (MEMBERS OF THE PUBLIC.)

Any person who is not regularly employed in using radioactive materials or radiation producing devices shall not receive in a calendar year from all sources of radiation a dose in excess of 2 percent of the limits in Section 2.2.1. This includes inspectors, casual visitors, maintenance repair persons, etc.

2.2.6 SURFACE CONTAMINATION

Any detectable contamination must be cleaned. Surface level results above those listed here must be decontaminated. These levels are determined by a wipe test unless otherwise noted. Generally, a beta/gamma survey meter reading of twice background on the surface in question indicates the presence of radioactive contamination and necessitates cleaning.

Item	Alpha	Beta/Gamma
Skin, hair, clothing, shoes	ND*	100 dpm/100 cm^2**
Cold areas (office, other labs, etc.)	ND*	100 dpm/100 cm^2
Equipment, lab surfaces, floors, controlled areas ***	5 dpm/100cm^2	100 dpm/100 cm^2

* Non-detectable
** Disintegrations per minute
*** 1000 dpm/100 cm^2 for ^3H

In those cases where surface contamination is found, but is not removable, the item must either be discarded as radioactive waste or the contamination permanently fixed to the item and the surface conspicuously labeled as contaminated. Clothing that cannot be decontaminated will be held for decay (if reasonable) or disposed of as radioactive waste. Personnel whose skin cannot be decontaminated will be dealt with as indicated by the type, extent and location of the contamination.

2.3 PERSONNEL MONITORING (DOSIMETRY)

Personnel monitoring is required for anyone who enters an area in which he or she may receive in one calendar year an exposure to a major portion of the body in excess of **10** percent of the limits in Section 2.2. A personnel dosimeter is required in this case. Personnel dosimeters are issued by the Radiation Safety Officer and his staff. Dosimeter as defined in the Glossary is "A device that measures radiation exposure, such as a dosimeter badge, ionization chamber, or "TLD".

2.3.1 DOSIMETER

1. The **aluminum oxide dosimeter** is **a new concept in personnel dosimetry material which is** currently used on the Campus and at satellite facilities. It is a device used to measure the total exposure received by a person exposed to beta, X, and gamma radiation. **Neutron radiation is measured by a small device attached within the aluminum oxide dosimeter.**

2. The **dosimeter** is used to provide the permanent radiation exposure history for the wearer. Therefore:

   a. It will only be worn by the person to whom it is issued.

   b. It will be worn in a location on your person (body trunk) where it is likely to receive the highest exposure on your whole body;

   c. Care must be taken not to shield it with other devices such as ID badges, pens/pencils, coins, keys, aprons, etc.

   d. It must not be lost, damaged, or exposed to radiation except while being worn for occupational purposes.

   e. It will be exchanged every two months (usually on or about the 1st of the month beginning with January.)

   f. It will not be used at locations other than the Campus and satellite facilities.

3. Wrist badges may be issued in cases where the hands may be exposed to significantly higher doses than the whole body. Wrist badges are issued upon reasonable request, i.e., use with ^{3}H would not be reasonable because the badge could not detect the low energy beta from the ^{3}H isotope. They will be issued when the RSO determines a requirement exists with respect to the isotope, activity and experiment performed.

2.3.2 THERMOLUMINESCENT DOSIMETERS (TLD)

The thermoluminescent dosimeter is a device used for measuring the total exposure by beta, gamma, and/or neutron radiation. The TLD will be issued in all cases where personnel are using ^{32}P and other isotopes/radiation sources as determined by the Radiation Safety Officer and his staff. Ionizing radiation striking the chips is "stored" by raising the electrons within the medium to a higher energy. When the chips (1/8 x 1/8 x 0.035 in.) are heated to a high temperature (approximately 355 ^{0}C), the electrons return to their ground state and light photons are emitted. The quantity of light is directly proportional to the exposure (in rads) received by the TLD. Since the TLD is used to provide permanent radiation exposure history, the same rules for dosimeters in Section 2.3.1.2 apply.

2.3.3 SELF READING DOSIMETERS

1. Direct self reading dosimeters operate on the principle of the gold-leaf electroscope. A quartz fiber is displaced electrostatically by charging it. An image of the fiber is focused on a scale and can be seen by looking through the dosimeter lens. Exposure of the dosimeter to X or gamma radiation (only) discharges the fiber and the fiber will return to its original position. The amount of discharge and therefore the amount of change in the fiber position is proportional to the radiation exposure.

2. Self reading pocket dosimeters may be worn by radiation workers in addition to, but not in lieu of, an assigned badge. Instances where this will be a requirement is when entering areas where one may expect to be exposed in excess of 100 mrem at 30 centimeters from source or surface that radiation penetrates (High Radiation Area). The user can immediately determine an accrued exposure by periodically checking the dosimeter.

3. Short term visitors such as inspectors, casual visitors, repair persons working on uncontaminated equipment in a radiation area will be issued a self-reading dosimeter in lieu of a permanent dosimeter. A log of all issued a dosimeter will be maintained reflecting the exposure indicated by the dosimeter. The RSO will determine when a dosimeter of this type will be worn.

4. Self reading dosimeters must be handled with care. A sharp blow, such as when dropped, may discharge it making its reading go off scale. In this case, an evaluation of the exposure must be made and the dosimeter recharged. The dosimeter must also be recharged at intervals given in the manufacturer's instruction manual.

2.3.4 ISSUING DOSIMETRY

Film badges and/or TLDs will be issued by the RSO to all personnel working with radioactive materials or radiation producing devices as required. Applications for dosimetry service may be obtained from the Radiation Safety Office (405-3984).

2.3.4.1 TEMPORARY PERSONNEL FROM OTHER FACILITIES

Individuals issued dosimeters while temporarily using UMD Campus or satellite facilities should request (after signing the appropriate release form) that the RSO send a copy of all exposure accrued at the University of Maryland to their home facility.

2.3.4.2 UNIVERSITY OF MARYLAND PERSONNEL VISITING OTHER FACILITIES

Any individual from the UMD Campus visiting other facilities who is occupationally exposed to radiation will request that facility to send a copy of records of exposure to the UMD RSO so that it may be be included in the annual exposure records. This is essential to assure that exposure limits are not exceeded.

2.3.5 EXPOSURE HISTORY

All records concerning personnel exposure are maintained indefinitely by the RSO. The amount of exposure received at the University of Maryland by an individual is determined after processing and recording exposures indicated by the film badges or TLDs. The total lifetime exposure on file of an individual is comprised of all exposures received at other facilities (if any) and at the University of Maryland.

2.3.5.1 LOST OR DAMAGED DOSIMETERS

An administrative dose will be determined for an individual when a film badge or TLD issued by the RSO is lost, damaged, or returned late. The exposure will be evaluated by any of the following methods:

1. Obtaining the individuals work history for the period in question and evaluating the exposure taking into consideration the work performed and past exposure history.

2. Averaging the recorded doses for the previous three periods.

In addition to an administrative dose the individual will be subject to Radiation Safety Procedure RSO #005A which requires a fine be charged based on the frequency of the lost, damaged or late dosimeter. The charge per frequency of occurrence is $10.00 first occurrence, $15.00 second occurrence, and $20.00 third occurrence. Accompanying the monetary fine is a 3-strike policy. Any individual receiving 3 strikes in one year is suspended until further notice from use and or possession of radioactive material or radiation producing devices.

2.3.6 BIOASSAY PROGRAM

Bioassays of occupationally exposed personnel will be performed when there is believed to be reasonable risk of internal radiation exposure. Bioassays are performed by the RSO and all results are on permanent file. If analysis shows any elevated content of the isotope in question approaching the annual limit of intake (ALI) listed in Appendix B of 10 CFR 20, Table 1, Column 1&2, the user will be referred to a clinic or hospital for further evaluation. A user will be allowed to return to work, if it is determined that he/she will not exceed the allowable exposure limits set by Federal and State Regulations.

Radioisotopes which require bioassays are listed on the Authorization for Possession and Use of Radioactive Materials issued to the Principle Investigators. Instructions for the appropriate bioassay are provided with the Authorization. Generally, all require a baseline measurement prior to use of an isotope exceeding the amounts listed in the Authorization.

Bioassays will be performed when:

(1) An adult is likely to receive, in one year, an intake in excess of 10 percent of the applicable ALI listed in Appendix B, 10 CFR 20, Table 1 Columns 1 & 2.

(2) A minor, or declared pregnant woman is likely to receive, in one year, a committed effective dose equivalent in excess of 0.05 rem (0.5 mSv).

3. RADIOACTIVE MATERIALS . POLICY AND PROCEDURES

The University of Maryland Campus has been issued a license to possess, use, and store radioactive materials by the State of Maryland. This license limits the amount of radioactive material (including materials created by radiation producing devices) which may be possessed, used and stored on campus. Individual users may be authorized by the Radiation Safety Officer and the Radiation Safety Committee (RSC) to possess, use and store radioactive materials. The total activity of these authorizations including radioactive waste on hand shall not exceed the amount listed on the license.

3.1 PERSONNEL AUTHORIZATION

3.1.1 PRINCIPAL INVESTIGATOR (PI)

Employees of the University of Maryland at College Park and personnel authorized to utilize University facilities by the Administration may be authorized as Principal Investigators by the Radiation Safety Officer and the Radiation Safety Committee. This Authorization may be for the Possession and Use of Radioactive Material or the Possession and Use of Radiation Producing Devices. Procedures for these authorizations are set forth in Section 3.2. Registration and certification of radiation producing devices are commented on in Section 4. and the Radiation Safety Manual Supplement.

3.1.2 UNDER 18 YEARS OF AGE

An individual who has not reached his/her 18th birthday shall not be occupationally exposed to radioactive materials or radiation producing devices such that he/she has the potential of exceeding 10% of the limits set in Section 2.2.

3.1.3 UNDERGRADUATE STUDENTS

In any instructional or research program in which undergraduate students are involved, radioactive materials or radiation producing devices will be used under the control of a Principal Investigator or Authorized User. At the request and recommendation of the Principal Investigator, the RSC and/or the Radiation Safety Officer may allow an individual to perform particular processes or functions when adequate training has been demonstrated and documented.

3.1.4 GRADUATE STUDENTS

Graduate students under instruction or performing research at the University will be governed by the rules set forth in Sections 3.1.2 and 3.1.3. However, when evidence is presented to the Radiation Safety Officer and/or the RSC that a graduate student has taken an approved course in radiation safety, laboratory procedures working with radioactive materials, and has had on-the-job training considered appropriate by the Radiation Safety Officer and/or the RSC in the use of comparable radioactive materials or devices, the student, at the request of the Principal Investigator, may be permitted to perform particular processes or functions without the immediate supervision of a faculty or staff member. A record of the student's training and experience will be sent the RSO to be filed with the Principal Use's Authorization for Possession and Use or Authorization for Radiation Producing Devices.

3.1.5 POSTDOCTORAL FACULTY OR RESEARCH PERSONNEL AND CLASSIFIED EMPLOYEES

Postdoctoral faculty or research personnel and classified employees, upon application to the Radiation Safety Officer and/or RSC, and having had the appropriate training as outlined in 3.1.4 above, may be authorized to supervise and use radioactive materials and radiation producing devices under the authority of a Principal Investigator.

3.1.6 NON-UNIVERSITY PERSONNEL

Personnel not employed by or attending the University who have been authorized by the Administration to utilize University facilities may make application to and obtain written approval by the Radiation Safety Officer and/or RSC for Authorization to use Radioactive Material or Radiation Producing devices. If the individual is qualified subject to the training requirements outlined in 3.1.4 above, to perform independent work, he may be permitted to do so under the authority of a Principal Investigator.

3.1.7 CASUAL VISITORS

Casual visitors **will not** be permitted to work with or use radioactive materials or radiation producing devices at the UMD Campus.

3.1.8 STUDENT PROGRAMS

Student programs, such as those involving undergraduates or minors, in which radioactive material or radiation devices shall be used will require a detailed protection program. This program usually takes the form of an application and authorization to Possess and Use Radioactive Material and/or Radiation Producing Devices. In all cases the program must be administered by a Principal Investigator or an Authorized User.

3.2 AUTHORIZATION PROCEDURES

See Figure 3.1, page 19 for a flow chart of the authorization procedures.

3.2.1 APPLICATION FOR POSSESSION AND USE OF RADIOACTIVE MATERIALS AND RADIATION PRODUCING DEVICES

To ensure compliance with the State issued Radioactive Material License, clear, concise, and accurate records of actual and/or proposed use of radioactive materials and radiation producing devices must be maintained. The application for possession and use of radioactive materials and radiation producing devices obtained from the RSO, includes all information necessary to ensure license compliance.

3.2.2 TRAINING AND EXPERIENCE OF RADIOACTIVE MATERIAL AND RADIATION PRODUCING EQUIPMENT USERS

All individuals applying for possession and use must complete and submit a training and experience (T&E) form and a Receipt of Radiation Safety Manual at the time of application. If approval is given by the Radiation Safety Officer and/or RSC, these will be filed with the authorization. All personnel who work without immediate supervision on the authorization, or are added to work as an authorized user must complete and submit the T&E form and Radiation Safety Manual Receipt form before approval will be given by the Radiation Safety Officer and/or RSC.

3.2.3 PROCESSING THE APPLICATION

Upon receipt of a new application and training and experience form, the RSO will review the application for completeness, and if additional information is necessary, will return it with a request for the information. When all necessary information is received, the RSO will visit the site(s) for a pre-authorization inspection.

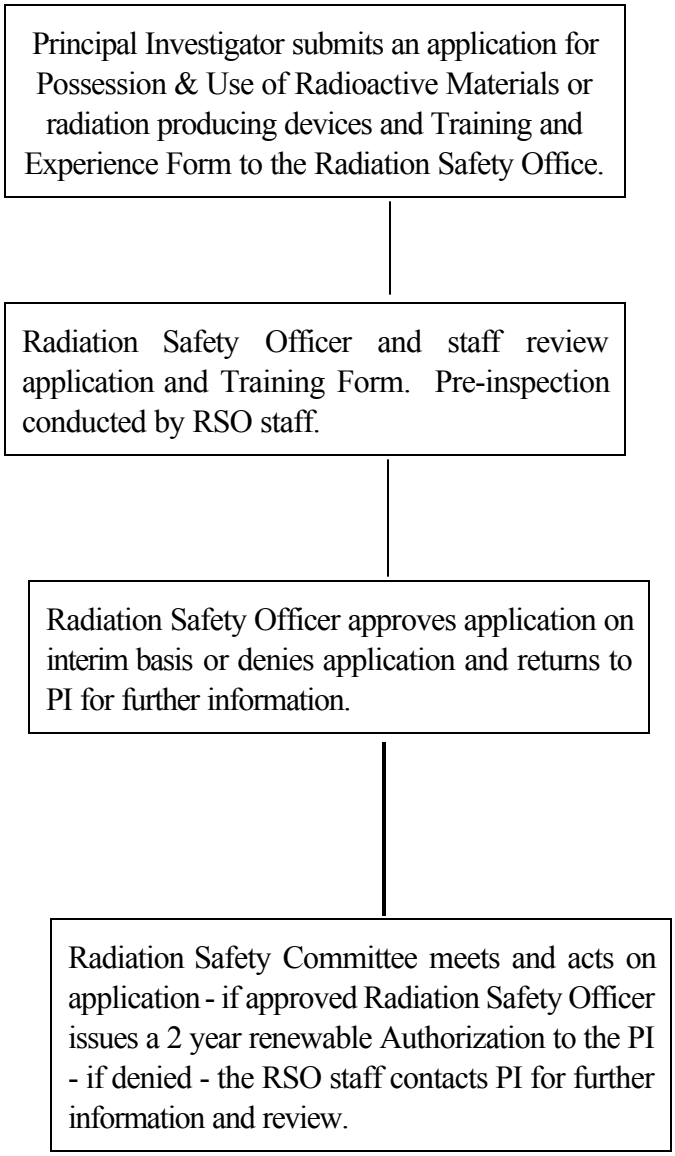
Based on the application, preauthorization survey, and review by the RSO, the Radiation Safety Officer and/or the Chairman of the RSC may issue an interim approval prior to the full review by the RSC. This entire package is then presented to the RSC for review at one of their 3 annual meetings. If approved, a formal authorization is issued by the Radiation Safety Officer.

3.2.4 RENEWAL OF AUTHORIZATION

Two months before the expiration date of an authorization, the Principal Investigator must notify the RSO in writing of his/her intention to renew the authorization. The RSO will then provide the user with the form for renewal which, when completed, will be returned to the RSO. The RSO will review the renewal application and present it to the RSC for action. If approved, a formal authorization will be issued by the Radiation Safety Officer.

Authorization Procedure Flow Chart

Figure 3.1



3.3 POSSESSION, RECEIPT AND INVENTORY OF RADIOACTIVE MATERIAL

The possession and use of radioactive materials is restricted to personnel who are currently authorized by the Radiation Safety Officer and/or the RSC and is limited to those isotopes in the **physical form and activity** specified in the authorization. These restrictions are necessary for health and safety reasons, and to assure compliance with the broad scope license issued to the University by the State of Maryland.

3.3.1 ORDERING RADIOACTIVE MATERIALS

All orders for radioactive materials will be placed through and **by** the Radiation Safety Officer and his/her staff. Orders for radioactive material shall be forwarded on the **University of Maryland, Radiation Safety Office, Radioactive Materials Order Form** to the Radiation Safety Office by campus mail or in person.

Radioactive Materials are ordered using the University Purchase Card system. All pertinent information must be included on the Order Form so that the order may be place by the RSO and his/her staff. A copy of the Order form is included in this manual as Appendix A, on page 54. The Order Form is available from your departmental business office or by calling the Radiation Safety Office at 405-3985.

3.3.2 RECEIPT OF RADIOACTIVE MATERIALS

All incoming shipments of radioactive materials including gifts, will be received by the RSO. Upon receipt, the RSO will complete all tests and surveys deemed appropriate and in accordance with the regulation for contamination control. An inventory control card shall be prepared for each item. Upon notification that the radio- active material has been received and is ready for pickup, the user or a designated representative will come to the Radiation Safety Office to take possession of the material. A copy of the inventory card shall be given to the user upon pickup of the item, and the person receiving the material will sign the receipt log.

3.3.3 INVENTORY CONTROL

Radioactive material inventory is maintained by the RSO staff on a computer program. Records are updated and maintained as required. When the material of a particular RSO number (assigned by the RSO) is no longer on hand (having been properly decayed, used or disposed of) the user will indicate this on their copy of the control inventory sheet supplied with the material when received, and return the copy (**with signature and date** of disposal or decay) to the RSO for removal from active inventory.

3.3.4 TRANSFER OF POSSESSION

1. Outside Agencies - Before material may be released to anyone not authorized under the UMD License the recipient will furnish the RSO with a copy of their current appropriate Federal or State license to insure that they are licensed to possess such material. This is necessary in order to comply with UMD and State and Federal regulations. A documented record of all such transactions will be maintained by the RSO.

2. Interdepartmental - Internal transfer of radioactive material must be approved by the Radiation Safety Officer. The recipient must have a current authorization for the same radioactive material (specific isotope) proposed to be transferred. Receipts of such transfers will be maintained by the parties involved and by the RSO.

3.4 USE OF MATERIALS IN SPACES NOT LISTED IN THE USER'S AUTHORIZATION - ON OR OFF CAMPUS

No radioactive material will be used or stored by an authorized user outside the laboratory area(s) listed on the authorization he/she is working under without first consulting with and obtaining written approval of the Radiation Safety Officer. This is particularly important when the material will be used at, and transported to, a facility not under the UMD Campus license. Use of material in an unauthorized space on campus only jeopardizes the UMD Campus license, whereas transport to and use at another facility may jeopardize their license as well.

3.5 TRANSPORTATION OF RADIOACTIVE MATERIALS

Section 3.5.1 and 3.5.2 apply only to packages in their original shipping containers and processed by the RSO or packaging inspected and approved by the RSO.

3.5.1 HAND TRANSPORT

Personnel listed as Individual or Authorized Users on the PI's Authorization may transport containers of radioactive material on campus. If a container, with appropriate shielding and postings, can be safely hand carried to the user's authorized area within the confines of the UMD Campus, then the user may do so. Such transportation will be done expeditiously via the most direct route. The container will be in the physical possession of the transporter at all times. No public roadways, such as Route 1, will be utilized.

3.5.2 VEHICULAR TRANSPORT

Vehicular transport may require the assistance of the Radiation Officer and his/her staff for packages not capable of being hand carried. If the package size or amount of shielding required precludes hand carrying, or public roadways must be utilized, inform the RSO so that these arrangements can be made. Authorized individuals must have received DOT training from the RSO in order to transport material in a vehicle on or off campus. In either case the individual must contact the RSO prior to transportation to ensure proper packaging, shipping and license compliance.

3.5.3 TRANSPORT BETWEEN AUTHORIZED AREAS

Radioactive materials (including waste) that must be moved from one room or area to another within interconnecting buildings, in general, may be moved without consulting the RSO, **provided:**

1. Both rooms or areas are listed on the user's Authorization.

2. Proper shielding, if required, is utilized to keep exposure ALARA.

3. The package is labeled with suitable radiation labels.

4. The package is capable of containing all the material, in case of an accident, in order to avoid contamination.

5. The package is moved expeditiously via the most direct route and in the physical possession of the transporter at all times.

3.6 STORAGE

3.6.1 UNSEALED SOURCES OF RADIATION

Radioactive materials that are not encapsulated by a solid material or permanently plated on metal are considered unsealed sources of radiation. As such, they are the most likely to cause contamination in the laboratory. These materials, when not in use, will be stored in a location that will prevent or minimize accidental spillage. Shielding requirements are normally met with the original shipping container. If additional shielding is required, it will be commensurate with the radiation emitted.

1. If the material is of a composition requiring refrigeration, the refrigerator will be plainly placarded for radioactive material storage only, and no food or drink will be stored in the same refrigerator.

2. If the material poses a possible airborne hazard, storage space shall be found in a working fume hood. As in all cases of storage, the container and shielding will be plainly marked as radioactive, with the contents listed in units of uCi, mCi, etc... as appropriate.

3. If the material requires neither 1 nor 2 above, then a relatively inaccessible storage space such as a cabinet, locker, or drawer may be utilized. The outside of the storage container, as well as the source and shielding within, will be plainly marked as radioactive.

3.6.2 SEALED SOURCES OF RADIATION

Those radioactive materials that are encapsulated or plated are considered sealed sources and are less likely to cause contamination. These sources are normally used for experimentation, calibration, comparison, or as light sources. The shielding requirements are the same as for unsealed sources.

3.6.3 SPECIAL CASES

Occasionally, material is received that requires special handling in transport, storage, use, and disposal. In all such cases, the RSO will assist in establishing a program that ensures health and safety, as well as compliance with Federal, State, and UMD Campus directives.

3.6.4 RADIOACTIVE WASTE

Radioactive waste will be stored in containers provided by the Hazardous Waste Section and approved by the RSO. These containers and their contents require the same concern as the material in Section 3.6.1. Radioactive waste requirements are set forth in Section 3.9.

3.7 SIGNS, LABELS, AND SIGNALS

The use of warning or caution signs is necessary to warn unauthorized or unsuspecting personnel of a hazard and to remind authorized personnel as well. The placement of certain signs and signals and the geometric dimensions of the radiation symbol and colors are provided in the State regulations. Signs and labels are available from the RSO.

3.7.1 GENERAL REQUIREMENTS

1. Radioactive Materials, Radiation Areas, High Radiation Areas, Airborne Radioactivity Areas, shipping containers and vehicles will be marked or posted as required by various regulations. The RSO will assist in providing the necessary information, signs, and/or labels.

2. All signs, labels, and signals will be posted in a conspicuous place.

3. All radiation control areas, including Radiation Areas, Contamination Control Areas, and Airborne Radioactivity Areas will be established by a barrier. Walls, fences, rope, or tape may be used to define the boundaries of a controlled area.

3.7.2 RADIATION AREA

Radiation Area signs (Figure 3.2) will be posted at all entrances to any room, laboratory or other area where a person could receive a dose equivalent in any one hour in excess of 5 mrem at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

3.7.3 HIGH RADIATION AREA

High Radiation Area signs (Figure 3.3) will be posted at all entrances to any area where a person could receive a dose equivalent in any one hour in excess of 100 mrem at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

In addition to this posting, all such entrances will:

1. Have a control device which upon entry into the area will cause the radiation level to be reduced below the level at which an individual might receive a dose of 100 mrem in 1 hour, or

2. Have a control device which will activate a conspicuous audio or visual alarm in such a manner to alert the individual entering the area and the supervisor of the facility of the entry, or

3. Be kept locked except during periods when access to the area is required with positive control over each individual entry. Keys for entry will be available to authorized personnel only, or

4. Be under direct surveillance if the High Radiation Area is to be established for a period of less than 30 consecutive calendar days.

3.7.4 VERY HIGH RADIATION AREA

A very high radiation area will be posted with appropriate warning signs where radiation levels could result in the person receiving an absorbed dose in excess of 500 rads in one hour at one meter from a radiation source or from any surface that the radiation penetrates.

The same additional requirements listed above (3.7.3 1-4) apply to the very high radiation area.

Figure 3.2

RADIATION AREA SIGN

Figure 3.3

HIGH RADIATION AREA SIGN

3.7.5 AIRBORNE RADIOACTIVE AREA

Airborne Radioactivity Area signs (Figure 3.4) will be posted at all entrances to any area where airborne radio- activity persists for a period in excess of 8 hours. Entry during any period of airborne radioactivity will be strictly controlled by the Principal Investigator, or his appointee.

3.7.6 ROOMS OR AREAS

1. A Radioactive Materials sign (Figure 3.5) will be posted at all entrances to an area where unsealed sources of radiation are used or stored. This includes areas where radioactive waste is kept in an accessible condition.

2. If a room or area meets the conditions in Sections 3.7.2 or 3.7.3 and radioactive materials are used or stored, then the appropriate sign and the Radioactive Materials sign or a combination of the two signs (Figure 3.6) will be posted.

3.7.7 CONTAINERS AND LABORATORY EQUIPMENT

All containers of unsealed sources of radiation (including waste) and all laboratory equipment used in any operation involving such material will be appropriately labeled or tagged. See Figure 3.7.

3.7.8 SEALED SOURCES

1. If the conditions of Section 3.7.2 or 3.7.3 do not exist in an area where sealed sources are stored, the entrance need not be posted, provided, that the radiation level 30 centimeters from the surface of the source container or housing does not exceed 5 mrem/hr, and the storage location (drawer, cabinet, refrigerator, room, etc.) provides adequate security for the source.

2. The outside of the storage container within such an area will be conspicuously posted with the sign in Figure 3.5.

3. In addition, if each sealed source is not permanently imprinted or embossed with the appropriate symbol and wording of any color, the label shown in Figure 3.7 will be affixed to each source.

Figure 3.4

AIRBORNE RADIOACTIVITY AREA SIGN

Figure 3.5

RADIOACTIVE MATERIAL SIGN

Figure 3.6

COMBINED RADIOACTIVE MATERIAL AND RADIATION AREA SIGNS

Figure 3.7

RADIATION MATERIALS LABELS AND TAGS

3.8 SURVEYS AND INSPECTIONS

3.8.1 RADIOACTIVE MATERIAL USERS

The radioactive material user has the primary responsibility for the control of radioactive contamination. The procedures outlined below will be followed when using unsealed radioactive materials, i.e., any material which is not a solid metal or permanently encapsulated.

Since individual circumstances vary widely with regard tomaximum activity, physical and chemical form of nuclides used, and to the various laboratory procedures in which radioactive material is employed, it is reasonable and prudent to attempt some classification of radioisotope facilities to determine the radiotoxicity of isotopes employed and how frequently they should be surveyed.

It is also recognized that radioactive materials are not in constant use in some laboratories on campus. Surveying laboratories for radioactive contamination during periods of infrequent use will be performed by the user. The RSO may be consulted to determine a reasonable and prudent survey frequency under such circumstances.

If for instance, such materials are used only for one laboratory a semester, only during the period of use would these guidelines apply. If the materials are placed in storage for the remainder of the year, surveys of the laboratory are unnecessary during the storage period. An entry will be required in the wipe log to indicate that "no RAM was used" for each month of inactivity. The storage site will require surveying during the storage period.

3.8.1.1 CLASSIFICATION

The method adopted, which is taken from "Report of Committee V, International Commission on Radiological Protection (ICRP) 1965", designates three levels of survey frequency based on radionuclide, activity per use, and radiotoxicity.

Users must first classify their laboratory areas, utilizing the attached two tables. Locate the isotope(s) used in Table 3.1 to determine the group classification to which the laboratory conforms. Then, utilizing Table 3.2, determine the appropriate survey frequency group, based on the amount per use.

For example:

An experiment is conducted employing a vial containing ^{125}I. The vial contains 5 mCi, and is opened to the laboratory environment while 1 mCi is removed. The vial is then resealed and returned to storage. First, locate ^{125}I in Table 3.1 in Group II. Then locate 5 mCi ^{125}I in Table 3.2 in Group II, Class II. The analysis indicates that the laboratory should be surveyed at least weekly while this level is employed. If it is a "one shot" only experiment, a survey should be done at the end of the experiment or at least once weekly which ever is shorter.

3.8.1.2 SURVEY METHOD

The current requirement of regulatory agencies stipulates that occupational radiation exposure be kept as low as reasonably achievable (ALARA). Contamination control is vital to this objective. The following survey methods are required for all users of radioactive materials:

1. Initial Survey

An initial survey will be conducted with an instrument, such as a GM tube or NaI crystal scintillation detector, to determine if contamination is present on a surface or in a particular area of a lab. The isotope employed shall determine the type of instrument that should be used in such a survey:

Type 1 - For gamma and beta emitters of sufficient energy, a GM tube may be used; a scintillation detector for the appropriate emitter may also be used.

Type 2 - For alpha emitters, an air proportional detector must be used. This device is available for a short term use from the Radiation Safety Office.

Type 3 - For low energy gamma emitters, a NaI crystal scintillation detector should be used.

Table 3.1
Classification of Radionuclides according to Relative Radiotoxicity per unit Activity

Group 1

Pb-210	Po-210	Ra-226	Ac-227	Th-227	Th-228	Th-230	Pa-231	U-230
U-232	U-233	U-234	Np-237	Pu-238	Pu-239	Pu-240	Pu-241	Am-241
Am-243	Cm-242	Cm-243	Cm-244	Cm-245	Cm-246			

Group 2

Na-22	Cl-36	Ca-45	Sc-46	Mn-54	Co-60	Sr-89	Sr-90	Y-91
Zr-95	Ru-105	Ag-110m	Cd-115m	In-114m	Sb-124	Sb-125	Te-127m	Tc-129m
I-123	I-125	I-126	I-129	I-131	Ca-134	Ca-137	Ba-140	Ce-144
Eu-152		Eu-154	Tb-160	Tm-170	Hf-181	Ta-182	Ir-192	Ti-204
Bi-210	At-211	Pb-212	Ra-224	Ac-228	Pa-230	Th-234	U-236	Bk-249

Group 3

H-3	C-14	F-18	Na-24	P-32	S-35	K-42	K-43	Ca-47
Sc-47	Cr-51	Mn-52	Fe-55	Fe-59	Co-57	Co-58	Ni-63	Ni-65
Zn-65	Ga-72	As-73	As-74	As-76	As-77	Se-75	Br-82	Kr-85m
Rb-86	Sr-85	Kr-87	Y-90	Nb-95	Mo-99	Tc-97	Tc-99	Ru-97
Ru-103	Rh-105	Pd-109	Cd-109	Ag-105	Ag-111	Sn-113	Sb-122	Te-129
Te-131m	Te-132	Xe-127	Ba-131	La-140	Ce-141	Ce-143	Pr-143	Nd-147
Nd-149	Pm-147	Pa-149	Sm-151	Sm-153	Eu-155	Gd-159	Dy-165	Ho-166
Er-169	Er-171	Tm-171	Yb-175	La-177	Re-186	Ir-190	Ir-194	Pt-191
Pu-197	Pt-197	Au-196	Au-198	Hg-197	Hg-197m	Hg-203	Ti-201	Ti-202
Pb-203	Rn-222	Th-231						

Group 4

O-15	Ar-37	Co-58m	Ni-59	Zn-69	Ga-71	Kr-85	Sr-85m	Rb-87
Y-91m	Zr-93	Nb-97	Tc-96m	Tc-99m	Rh-103m	In-113	Xe-131m	Xe-133
Ca-134m	Ca-135	Sm-147	Re-187	Os-191m	Pt-193m	Pt-197m	Th-232	U-235
U-238	U-Nat							

Table 3.2
Radioisotope Facility Classification

	CLASS I	CLASS II	CLASS III
Radionuclide Group	At least every 30 days	At least weekly	At least daily
I	≤ 0.01 mCi	.01 to 1.0 mCi	> 1 mCi
II	≤ 1.0 mCi	> 1.0 to 10.0 mCi	> 10 mCi
III	≤ 10 mCi	> 10 to 100 mCi	> 100 mCi
IV	≤ 100 mCi	100 to 1000 mCi	> 1000 mCi

NOTE: Isotopes such as ^{3}H, ^{35}S, and ^{14}C are difficult to detect with a GM detector and will not be relied upon as the sole method for detection of these isotopes. A wipe test will be used to determine the level of contamination when using these isotopes.

2. Wipe Test

The final item of this method is the wipe test. Any time unsealed sources of radioactive materials are used in the lab, a wipe test will be conducted and the results posted in the wipe log book in the units of DISINTEGRATIONS PER MINUTE (DPM).

(DPM = CPM / *Efficiency of Detector*)

Surface areas to be surveyed will be wiped with one inch discs of filter paper or parafilm, and the area per wipe will cover approximately 100 cm^2. These wipes will be placed in a vial containing standard scintillation cocktail and counted in a Liquid Scintillation Counter. If any reading exceeds 100 dpm, (1000 for ^{3}H) that area will be considered contaminated and will be cleaned. The RSO will be notified of a contamination condition.

3.8.1.3 TYPICAL AREAS FOR SURVEY

In handling radioactive, or any other material in liquid form, spills may occur. Spills are not the only way that contamination may occur. Some may be on your protective clothing, such as gloves or lab coats. The contamination may be spread by contact with other surfaces.

Areas of concern include, but are not limited to:

Lab bench top and side surfaces;
Fume hood interior and exterior surfaces;
Floor area in front of benches and hoods;
Lab chairs and stools;
Light switches;
Drawer and other handles;
Bare hands, after glove removal;
Shoe soles, seats of pants, etc.

3.8.1.4 RECORDS

A wipe log record will be kept of each survey performed. A record of the results of any wipe tests shall be maintained for 1 year in the log. In order to facilitate recording the survey results, it may be convenient to draw a sketch of the laboratory and block it off into grids. Then, when a wipe or instrument results is recorded, refer to the grid designation. Wipe log booklets are available from the Radiation Safety Office. <u>These records must always be available to the RSO and State Radiation Control staff for review.</u> Records (Printouts) of wipe test survey results data will be retained for 1 year.

3.8.2 RADIATION SAFETY OFFICE SURVEYS

The Radiation Safety Office will survey each laboratory that uses unsealed radioactive materials quarterly. Laboratories that show a record of violations of a repeat nature on these surveys will be inspected more frequently until a satisfactory finding of corrective actions has been achieved. Some of the more common violations and noncompliance issues are as follows:

1. Wipe Log: The monthly wipe test was not recorded in the laboratory wipe log; RSO personnel were unable to locate wipe log; the wipe log was not up to date.

2. Waste: Radioactive waste was found in an approved container but no entries were found on the container inventory card; waste containers were not clearly labeled with proper radioactive material stickers/labels; radioactive waste was found in unapproved and unlabeled waste containers.

3. Dosimetry: Individuals working with radioactive material requiring dosimeters and/or TLDs were not wearing their dosimetry; dosimeters in use were out of date.

4. Signs: Labels and signs appropriate for laboratories or equipment not found or missing.

The purpose of the RSO survey is to help the user maintain a safe work environment and will include:

1. Meter and wipe surveys of work surface, floor, refrigerators, hoods, etc., to assure no contamination.

2. A check of fume hoods to assure that they are in working condition and have sufficient air flow for use with radioactive materials.

3. A review of wipe log.

4. An interview with the user and/or occupant to determine if there have been any new or unusual occurrences since the last survey and if the RSO may be of any assistance.

5. A written report of the survey. Any deficiency found will be noted and details sent to the user for corrective actions.

All notices of violations require a corrective response. If a response is not provided to the RSO, the RSC will be advised and corrective action will be taken.

3.8.3 RESTRICTED AND UNRESTRICTED AREAS

Every area that requires posting with Radioactive signs is considered a restricted area. All other areas are considered unrestricted areas. Periodically, the RSO will measure the levels of radiation in unrestricted areas immediately adjacent to the restricted areas. It is incumbent upon the user to construct such shielding as required to minimize any radiation to unrestricted areas. The radiation level in an unrestricted area must be such that a dose does not exceed 2 mrem in one hour.

3.8.4 STATE OF MARYLAND

The State of Maryland, Department of the Environment will periodically visit the Campus for a license compliance inspection. The date of the inspection is determined by the State Agency and is unannounced. The inspection includes monitoring and record checks of the laboratory areas, inspection of procurement, disposal and inventory records, records of qualification of users, interviews with users and lab occupants, and a check of all aspects of the Radiation Safety Office functions, activities and records.

3.9 RADIOACTIVE WASTE

No radioactive materials (or materials which may be contaminated with radioactive materials) may be disposed of by conventional methods. Collection, storage, and removal of radioactive wastes must be carried out as specified in the following sections. Authorized users are responsible for keeping records of all disposals so that current inventories reflect actual amounts of isotopes on hand. Authorized users are responsible for their waste material until possession by the RSO is established. To have waste picked up from your lab access the Environmental Affairs page at: http://www.essr.umd.edu

3.9.1 GENERAL REQUIREMENTS

1. Ascertain that sufficient and appropriate waste containers are obtained from the Environmental Affairs section of ESSR and that specific instructions for their use are fully understood.

2. Aqueous and non-aqueous liquids, vials, and solid wastes will be kept in separate containers.

3. Liquid and solid radioactive waste will be separated by isotope, except as authorized by the RSO. Reactive chemicals must not be mixed.

4. Sharp objects will be disposed of in separate labeled sharps containers, so that personnel who must later handle the waste are protected.

5. A running inventory will be maintained on the outside of each container by isotope, activity, and chemical composition for liquid containers.

6. All containers will be clearly labeled CAUTION RADIOACTIVE WASTE or CAUTION RADIOACTIVE MATERIALS.

7. Radioactive waste will never be placed in regular, non-controlled, non-radioactive designated containers.

8. All radioactive waste will be stored in a manner so as to prevent:
   a. Contamination of laboratory space and personnel.
   b. Generation of airborne hazards.
   c. Incompatible mixing of chemicals.

9. Radioactive waste will be stored separately from other types of hazardous waste or chemicals.

10. Waste containers are available from the Environmental Affairs section of ESSR.

3.9.2 SOLID RADIOACTIVE WASTE

1. Solid radioactive wastes are all solid, dry, radioactive materials and laboratory waste such as gloves, absorbent paper, and used lab equipment which is or may be contaminated with radioactive materials.

2. Materials which have become contaminated (and cannot be decontaminated) and contains any organic solvents such as benzene, toluene, or xylene, will be strictly segregated from other dry waste. Even a small amount of these organic solvents will cause the entire container to be classified as organic radioactive waste and the entire shipment will be rejected at the disposal site.

3. Containers for solid radioactive waste must be procured from the Environmental Affairs section.

4. Waste containers for solid radioactive waste will be lined with a removable plastic liner. ESSR personnel supply liners with the waste containers.

5. Care will be taken to ensure that no sharp objects, such as needles, knives, razor blades, pipettes, or glassware are put in the plastic liner. Dry waste is normally compacted and must be handled by Environmental Affairs personnel.

6. Containers will be identified as to isotopes and a reasonable estimate of the activity of each isotope present in the container. A continuous listing will be maintained for all waste deposited in the container.

3.9.3 LIQUID RADIOACTIVE WASTE

1. All liquids, such as solvents, water, scintillation fluid, or other solutions, which contain or may contain radioactive materials are considered liquid radioactive waste.

2. Liquids will be segregated by type such as aqueous, organic solvent, scintillation cocktail, and by isotope except as authorized by the RSO. The techniques of waste preparation for final disposal vary greatly with each of these categories. The slightest solvent contamination causes the entire container to be classified as a mixed waste and disposal of this category is the most expensive and extremely difficult to dispose of off site.

3. Waste containers for liquid wastes are glass or poly-ethylene jugs and will be stored in such a manner that should the container be damaged or break, the contents will be completely contained (i.e., **within a secondary container)**. Secondary containers are available from the Environmental Affairs section of ESSR.

4. Waste containers will be fitted with a securely fitting stopper or cover and must remain closed except during times of use.

5. No material other than liquids will be placed in liquid radioactive waste containers.

6. Water and solvents will be separated at all times.

7. Special consideration will be given to liquid wastes to ensure that mixing of liquids does not result in an altered pH, unstable solutions, or the generation of gases.

8. ETHER will be disposed of only after consulting with the Environmental Affairs Manager or his staff.

9. Containers will be identified as to the isotope and a reasonable estimate of the activity of each isotope present in the container. A detailed chemical composition is also required. A continuous listing of this information will be maintained for all waste deposited in the container.

3.9.4 RADIOACTIVE VIALS

1. Small scintillation type vials containing liquid samples will be treated separately from solid or liquid radioactive waste.

2. Vials may be plastic or glass containing 5 to 15 ml of radioactive liquid or scintillation fluid. Each type will be disposed of in separate containers.

   a. Aqueous only. Radioactive Vials containing aqueous biodegradable scintillation cocktail and no hazardous chemicals will be placed into the appropriate container designated for **aqueous scintillation vials.**

   b. Organic only - Radioactive Vials containing a controlled hazardous substance, and **not exceeding** 0.05 uCi/ml per vial will be disposed of as **chemical waste only** and not as a radioactive waste.

   c. Mixed vials - Those meeting or exceeding the 0.05 uCi/ml limit shall be disposed of as radioactive waste vials and will be placed in their respective waste container separate from the Aqueous and Organic only vial.

      Vials containing ^{109}Cd, ^{26}Cl, ^{203}Hg, ^{125}I, ^{22}Na, ^{32}P, ^{33}P, and ^{35}S containing organic scintillation cocktail, and/or containing hazardous chemical wastes not exceeding the limits specified by the Environmental Affairs Section are allowed.

3.9.5 ANIMAL CARCASSES

1. Animal carcasses which may contain radioactive materials will be separated from other radioactive waste and from other animal carcasses.

2. All animal carcasses contaminated with radioactive materials will be placed in watertight bags or wrapped and isolated from other wastes. Carcasses need not be individually wrapped.

3. Carcasses will be frozen.

4. All syringes, needles, knives, glass and/or other sharp objects will be removed before packaging.

5. Large animal carcasses may have to be stored in a special manner as prescribed by the RSO on an individual basis.

6. All packages of animal carcasses containing radioactive materials will be marked with appropriate radiation labels and identified to the isotope present and a reasonable estimate of activity.

3.9.6 SPECIAL OR UNUSUAL WASTE

The RSO must be notified in advance when an experiment may cause special disposal problems, generate unusual wastes, an abnormally large quantity of waste, or when large animal carcasses are used. Appropriate guidelines for management of these wastes will be furnished after consideration by the Radiation Safety Officer and RSC.

3.9.7 DISPOSAL OF RADIOACTIVE WASTE

3.9.7.1 REMOVAL BY ESSR SAFETY PERSONNEL (ENVSA)

The ESSR Environmental Affairs personnel will pick up radioactive waste from your lab when notified via the ESSR website electronic pick up system. Wastes that pose special hazards, animal carcasses or other specially treated wastes will be collected from the laboratories by special arrangement. These materials will not be deposited with regular radioactive wastes. Waste is stored and collected from the labs or rooms where radioactive materials are authorized for use or storage. These areas will be secured at all times.

3.9.7.2 BURIAL

Burial of radioactive waste is not permitted in the State.

3.9.7.3 DISPOSAL INTO THE SANITARY SEWER

Release of radioactive materials into the sanitary sewer system by laboratory personnel (through sinks, drains, etc.) is prohibited.

3.9.7.4 INCINERATION

Incineration of radioactive materials is prohibited.

3.9.7.5 FINAL DISPOSAL

ESSR will transport and process all radioactive wastes in accordance with applicable regulations as established by the US Department of Transportation, the NRC, and State of Maryland Department of the Environment. Final disposal and removal from the UMD Campus is accomplished by approved contractors authorized for the functions by the above agencies.

3.10 SECURITY

All radioactive materials (including waste material) and/or radiation areas will be secured at all times. When not in the physical possession or immediate observation of the individual user, access to the material or spaces will be restricted by locked doors, or locks on the immediate storage facility (refrigerators, freezers, cabinets, etc.).

4. RADIATION PRODUCING DEVICES

Any machine or device which is capable of producing ionizing radiation will be authorized for use by the UMD Radiation Safety Committee and registered and certified with the State of Maryland through the RSO. This registration and certification is valid for a specified period depending on the device and will be renewed by re-application through the Radiation Safety Office. The authorization, registration, and certification must be completed **before the equipment is put into service**. See UMD Radiation Safety Manual Supplement for further information. This manual is available in the RSO.

Exceptions to this requirement are those devices which produce radiation incident in their normal operation, such as television equipment, VDTs, high voltage power supplies, etc., providing the equivalent dose rate does not exceed 0.5 mrem/hr/10 cm^2 at 5 cm from any accessible surface.

Additional information concerning State fees and applicable regulations are available in the Supplement and will be provided to users where required, or upon request.

5. REQUIRED POSTINGS . ALL USERS

The instructions and notices in this section will be posted in such a manner that workers may see them on the way to or from any facility engaged in radiation work. All are available from the RSO.

5.1 RADIATION EMERGENCY PROCEDURES

In the event of any occurrence out of the ordinary involving radioactive materials or radiation producing devices, a guide to user response has been prepared (Figure 5.1 Radiation Emergency Procedures). Any event, no matter how small or trivial, will be reported immediately to the RSO, as some circumstances require immediate notification to State authorities.

5.2 NOTICE TO EMPLOYEES

Pursuant to State regulations, a notice of employer's and employees responsibilities will be posted. In conjunction with this notice is a listing of public documents which may be found at the Radiation Safety Office. See Figure 5.2.

5.3 NO SMOKING, EATING, OR DRINKING

Internal contamination is not only the most dangerous type of radiation exposure to be encountered at UMD Campus, but is also the most difficult to detect. Smoking, eating, drinking, chewing gum or tobacco, applying cosmetics, etc., in any area where radioactive materials are employed invites internal contamination by inhalation, ingestion or both and is therefore prohibited. See Figure 5.3.

Figure 5.1

RADIATION EMERGENCY PROCEDURES

Radiation Safety Office
Chemical & Nuclear Engr. Bldg
Room 2124
College Park Campus

Emergency Numbers
911
Anytime - 405-3333
Daytime - 405-3985

Type of Emergency	Hazard	Immediate Actions	Follow-up
Minor Spill	No immediate hazard to personnel	1. Alert personnel in area 2. Confine the spill	1. Decontaminate 2. Record in wipe log
Major Spill	Radiation Level may be high depending on isotope	1. Alert personnel in area 2. Confine the spill 3. Vacate area 4. Contact RSO (5-3985) 5. Assist in decontamination	1. Decontaminate 2. Record in wipe log 3. Submit bioassay samples if needed 4. Review incident with lab personnel
Incident involving dusts, mists, fumes gases or vapors	Internal radiation hazard if inhaled or deposited on skin	1. Alert personnel in area 2. Vacate the area 3. Contact RSO (5-3985) 4. Secure area from all personnel 5. Assist in decontamination	1. Decontaminate 2. Record in wipe log 3. Submit bioassay sample if needed 4. Review incident with personnel
Injured personnel	Internal radiation hazard through open wound, on skin or inhaled	1. Alert personnel in area 2. Vacate area 3. Call 911 (if needed) 4. Notify RSO (5-3985) 5. Other personnel assist in decontamination	1. Decontaminate 2. Record in wipe log 3. Submit bioassay sample if needed 4. Review incident with personnel
Fires	Internal radiation hazard and physical harm from fire	1. Alert personnel in area 2. Pull fire alarm 3. Vacate the building	1. Follow RSO directions for post clean up and decontamination
X-rays	Superficial burn or deep burn	1. Shut off the machine 2. Call 911 3. Contact RSO (5-3985)	1. Lock out device 2. Secure from use 3. Follow RSO directions for investigation

Figure 5.2

DEPARTMENT OF THE ENVIRONMENT
DIVISION OF RADIATION CONTROL
2500 Broening Hwy, Baltimore, MD 21224

Radiological Health
(410) 631-3300
Night/Weekend
1- (800) 633-6101

NOTICE TO EMPLOYEES

In part D of its Rules and Regulations, (COMAR 26.12.01.01) The Maryland State Department of the Environment has established standards for your protection against radiation hazards. In Part J, DOE has established certain provisions for the options of workers engaged in work under an Agency License or Registration.

YOUR EMPLOYER'S RESPONSIBILITY -

1. Apply these regulations to work involving sources of radiation.
2. Post or otherwise make available to you, a copy of the Maryland State Department of the Environment regulations, licenses, notices of violations, and operating procedures which apply and explain their provisions to you.

YOUR RESPONSIBILITY AS A WORKER-

You should familiarize yourself with those provisions of the regulations and procedures which apply to the work you are engaged in. You should observe their provisions for your own protection and the protection of your co-workers.

WHAT IS COVERED BY THESE REGULATIONS -

1. Limits on exposure to radiation and radioactive material in restricted and unrestricted areas.
2. Measures to be taken after accidental exposure.
3. Personnel monitoring, surveys, and equipment.
4. Caution signs, labels, and safety interlock equipment.
5. Exposure records and reports.
6. Options for workers regarding Agency inspections; and
7. Related Matters.

REPORTS ON YOUR RADIATION EXPOSURE HISTORY -

1. The regulations require that your employer give you a written report if you receive an exposure in excess of any applicable limit as set forth in the regulations or in the license. The basic limits for exposure to employees are set forth in Sections D.201, D.203, and D.204 of the regulations. These sections specify limits on exposure to radiation and exposure to concentrations of radioactive material in air and water.

2. If you work where personnel monitoring is required:
   a. Your employer must give you a written report, upon termination of your employment, or your radiation exposure.
   b. Your employer must advise you annually of your exposure to radiation.

INSPECTIONS -

All licensed or registered activities are subject to inspection by representatives of the Maryland State Department of the Environment. In addition, any worker or representative of workers who believes that there is a violation of the Maryland Radiation Act, the regulations issued thereunder, or the terms of the employer's license or registration with regard to radiological working conditions in which the worker is engaged, may request an inspection by sending a notice of the alleged violation to the Maryland State Department of the Environment. The request must set forth the specific grounds for the notice, and must be signed by the worker or the representative of the workers. During inspections, Agency inspectors may confer privately with workers, and any worker may bring to the attention of the inspectors any past or present condition which he believes contributed to or caused any violation as described above.

POSTING REQUIREMENT

Copies of this notice must be posted in a sufficient number of places in every establishment where employees are employed in activities licensed or registered, pursuant to Part B or Part C to permit employees working in or frequenting any portion of a restricted area to observe a copy on the way to or from their place of employment.

LOCATION OF REGULATIONS AND RECORDS

Copies of all regulations, licenses, and personnel exposure record applicable to the use of radioactive materials, radiation producing sources and equipment are located in the University of Maryland Radiation Safety Office for your review.

Figure 5.3

NO SMOKING ,

EATING, OR DRINKING

PERMITTED

IN THIS AREA

6. VIOLATIONS, SUSPENSIONS, AND APPEALS

6.1 VIOLATIONS

The Principal Investigator of radioactive materials and/or radiation producing devices will, when cited for non. compliance of applicable UMD Campus, State and Federal regulations, act to be in compliance as soon as possible. The RSO will assist the user if necessary or requested.

6.2 SUSPENSIONS

1. The Radiation Safety Officer is charged with recommending to the Vice President for Academic Affairs and Provost the suspension of activities or operations in any campus facility where there is a disregard for compliance with appropriate regulations, a significant safety, health or property damage hazard exists, and independently suspending activities or operations which could reasonably be expected to cause serious harm or cause death when the responsible individual will not or cannot correct the condition immediately.

2. In the event that the Radiation Safety Officer deems it necessary to close a laboratory, the closing order will be placed in writing and immediately forwarded to the user. Included in the order will be a statement of the right to appeal the action before the RSC.

6.3 APPEALS

In the event that a program or operation is suspended under Section 6.2, the user has the right to appeal the suspension to the RSC. When a written request to appeal is received by the Chairperson of the RSC, the RSC will meet within five (5) working days to hear the appeal. Upon hearing the appeal, the RSC will (by initial verbal order, and if reasonable, followed by a written statement) uphold or rescind the suspension and make recommendations to alleviate the current and any future problems.

The RSC has the responsibilities stated in Section 1.2 as well as the full authority to terminate an authorization for possession and use of radioactive materials, and the use of radiation producing devices on the UMD Campus.

GLOSSARY

ABSORBED DOSE: The energy imparted to matter by ionizing radiation per unit mass of irradiated material.

AIRBORNE RADIOACTIVE MATERIAL: Any radioactive material dispersed in the air in the form of dusts, fumes, mists, vapors, or gases.

ALARA: A program that is used to ensure that personnel radiation exposure is kept As Low As Reasonably Achievable.

AUTHORIZED USER: A person who is authorized by the Principal Investigator to perform procedures or use radiation producing equipment without supervision.

CASUAL VISITOR: A person who is visiting without intent to participate in the operation or program of a laboratory such as a person on tour, an inspector, etc.

CURIE: The basic unit to describe the intensity of radioactivity in a sample. 1 Ci = 3.7×10^{10} disintegrations per second.

DECLARED PREGNANT WOMAN: Declaration made by a woman who has voluntarily informed her employer, in writing, of her pregnancy and the estimated date of conception.

DOSE: Absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, or total effective dose equivalent.

DOSE RATE: The radiation dose delivered per unit time and measured, for instance, in rems per hour.

DOSIMETER: A device that measures radiation dose, such as film badge, ionization chamber, or TLD.

DOSIMETRY: The measurement of the amount of radiation delivered to a specific place or the amount of radiation that was absorbed there.

EXPOSURE RATE: The amount of ionization produced in air per time, in units of R/hr for example.

HIGH RADIATION AREA: Any area accessible to individuals, in which there exists radiation at such levels that a major portion of the body could receive a dose in excess of 100 millirem (mrem) in one hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

INDIVIDUAL USER: Any individual who works with radioactive materials, or radiation producing equipment.

INDUCED RADIOACTIVITY: Radioactivity that is created when substances are bombarded with neutrons, as from a nuclear reactor, or with charged particles produced by accelerators.

NON IONIZING RADIATION: Radio or microwaves; visible, infrared or ultraviolet light.

NRC: United States Nuclear Regulatory Commission

OCCUPATIONAL DOSE: Exposure of an individual to radiation (1) in a restricted area; or (2) in the course of employment in which the individual's duties involve exposure to radiation.

PARTICLE ACCELERATOR: A machine capable of accelerating electrons, protons, deuterons, or other charged particles in a vacuum and of discharging the resultant particulate or other radiation into a medium at energies usually in excess of 1 Mev.

PERSONNEL MONITORING: Determination by either physical or biological measurement of the amount of ionizing radiation to which an individual has been exposed, such as by measuring the darkening of a film badge or performing a radon breath analysis.

PRINCIPAL INVESTIGATOR: The individual responsible for a particular program. This individual may be called the Principal Investigator and is authorized by virtue of UMD procedures to engage in the activity where controls and accountability are required.

RAD: The basic unit of absorbed dose of ionizing radiation. A dose of one rad means the absorption of 100 ergs of radiation energy per gram of absorbing material.

RADIATION: Ionizing radiation, i.e., gamma rays, x- rays, alpha and beta particles, high speed electrons, neutrons, and other nuclear particles.

RADIATION AREA: Any area accessible to individuals in which there exists radiation at such levels that a person could receive a dose equivalent in excess of 5 millirems (mrem) in one hour at 30 centimeters from the source or any surface that the radiation penetrates.

RADIOACTIVE MATERIAL: Any material (solid, liquid, or gas) which emits radiation spontaneously.

RADIOACTIVITY: The disintegration of unstable atomic nuclei by the emission of radiation.

REM: A special unit of any of the quantities expressed as dose equivalent. The dose equivalent in rems is equal to the absorbed dose in rads multiplied by the quality factor.

RESTRICTED AREA: Any area where access is controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials.

RSC: Radiation Safety Committee.

RSO: Radiation Safety Office.

TLD: Thermoluminescent dosimeter.

UMD: University of Maryland Campus and all properties under its control.

UNRESTRICTED AREA: Any area where access is not controlled or limited by the licensee.

VERY HIGH RADIATION AREA: An area accessible to individuals, in which radiation levels could result in an individual receiving an absorbed dose in excess of 500 rads in one hour at one meter from a radiation source or from any surface that the radiation penetrates.

INDEX OF FIGURES AND TABLES

Appendix A

University of Maryland
Radiation Safety Office
Radioactive Materials Order Form

Use this form to request the purchase of **radioactive material** using Departmental Purchasing Cards. Upon completion of this form, forward a copy to the Radiation Safety Office, Chemical & Nuclear Engineering, Room 2124, Building 090. You may **(1)** send a copy through campus mail; or **(2)** have someone hand deliver the order to our office. Your order will be placed by the Radiation Safety Office staff using the purchasing card number you indicate in the space provided.

(Please print)

Date	Name of Cardholder
UMD Purchasing Card Number	Expiration Date
Department Phone Number	Business Manager **Signature**

(Description of items)

Vendor Name	Catalog Number
Product Name	Activity (amount) _____ uCi _____mCi
PI Name (print)	

The Radiation Safety Office will forward the invoice and packing list that comes with the product to the Business Manager of your department.

This request for radioactive material will **NOT** be processed without a proper signature and description of item. If you have any questions please contact the Radiation Safety Office staff at (301)-40**5-3985**