

# **RADIATION SAFETY MANUAL**

**William & Mary  
Williamsburg Campus  
Williamsburg, Virginia**

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*The policies and procedures discussed in this manual are in compliance with regulations first established by the Nuclear Regulatory Commission (NRC) under Title 10, Code of Federal Regulations (CFR). This manual reflects and is consistent with the subsequent transfer of this authority to the Virginia Radioactive Material Program (VRMP) as an "Agreement State," in April 2009. The program is conducted in accordance with Chapter 481, "Virginia Radiation Protection Regulations." The current License, all records, forms, and operating procedures, as well as copies of the regulations are available from the Radiation Safety Officer.*

## TABLE OF CONTENTS

<b>I. OVERVIEW OF THE RADIATION SAFETY PROGRAM .....</b>	<b>3</b>
A. PURPOSE OF THE MANUAL.....	3
B. ORGANIZATION OF THE RADIATION SAFETY PROGRAM.....	3
<b>II. BASIC STANDARDS of MAXIMUM PERMISSIBLE EXPOSURE.....</b>	<b>6</b>
A. STANDARDS FOR OCCUPATIONAL RADIATION WORKERS.....	7
B. POLICIES DESIGNED TO MINIMIZE EXPOSURES (ALARA).....	8
C. ALARA PROGRAM ASSURANCE REVIEW.....	9
<b>III. HANDLING OF RADIOISOTOPES AND ASSOCIATED RECORD KEEPING.....</b>	<b>9</b>
A. DESIGNATION OF RADIOACTIVE MATERIAL WORK AREAS .....	9
B. PROCUREMENT OF ISOTOPES .....	9
C. RECEIPT OF RADIOACTIVE MATERIAL .....	9
D. STORAGE OF ISOTOPES .....	10
E. USE OF RADIOACTIVE MATERIAL AND ROUTINE SURVEY PROCEDURES .....	11
F. DISPOSAL OF RADIOACTIVE MATERIAL .....	13
G. RECORD KEEPING .....	13
<b>IV. EMERGENCY PROCEDURES .....</b>	<b>14</b>
<b>V. BASIC RULES OF RADIATION SAFETY .....</b>	<b>14</b>
<b>VI. CONTACT PERSONS .....</b>	<b>15</b>
<b>VII. APPENDIX A – FORMS .....</b>	<b>15</b>

## **I. OVERVIEW OF THE RADIATION SAFETY PROGRAM**

### **A. INTRODUCTION AND OVERVIEW**

The purpose of this Radiation Safety Manual is to provide faculty, staff, and students at William & Mary with the information required to ensure the safe and appropriate use of radioactive materials in compliance with state and federal policy. More specifically, it is designed to familiarize those using radioactive materials or those working in areas designated for the use of radioactive materials on the Williamsburg Campus of William & Mary with the applicable guidelines and policies for the use of radioactive materials. All approved operations adhere to the policy of ALARA: they are designed to ensure that exposure is kept, in compliance with federal and Commonwealth of Virginia policy, As Low As Reasonably Achievable (ALARA).

### **B. ORGANIZATION OF THE RADIATION SAFETY PROGRAM**

#### **1. LICENSE:**

The Virginia Radioactive Materials Program (VRMP) has granted a license to the College of William & Mary for the use of specified nuclear by-products, as well as accelerator-produced and naturally occurring radioactive materials. This license provides for the possession and use of small (under 100 $\mu$ Ci) sealed sources of radioactive materials with atomic numbers 1 through 96, except in a few specific cases delineated below where larger amounts have been permitted. Under the terms of this license, millicurie amounts of specific byproduct materials that are not sealed, and are in a form for use in chemical and biological synthesis, are also permitted. The details of the isotopes that are permitted and the specific limits for each isotope may be found in the current license.

#### **2. PERSONNEL AND USER STATUS:**

##### Radiation Safety Program Personnel

RSO: A Radiation Safety Officer (RSO) is designated by the Provost (and approved by VRMP), to oversee all usage of radioactive materials on the Williamsburg Campus (note: William & Mary Batten School of Coastal and Marine Sciences in Gloucester Point, Virginia holds a separate radioactive materials license and has a separate RSO). The Williamsburg Campus RSO will ensure the safety of users and the surrounding community by monitoring all aspects of radiation safety. All work with unsealed or sealed byproducts will be approved by the RSO. In addition, following any spill, exposure, or any type of accident or irregularity, a disposition report must be made to the RSO as soon as possible so that a proper report of the incident may be made to the Virginia Radioactive Materials Program (VRMP) for the record, if necessary. The current RSO is Eric L. Bradley, Ph.D., Biology Department.

Authorized Users: In addition, Authorized Users will be identified by the RSO (with confirmation by the provost) to assist with the radiation safety program, particularly in their area of expertise. The Authorized Users will function as a mutual-aid and advisory group to support the safe and effective use of all radioactive materials and further agree to take the responsibility to serve as a designated "first responder" to radioisotope accidents or problems that may develop with radioactive materials in their designated areas. Authorized Users will have demonstrated extensive theoretical knowledge and considerable on-the-job experience in all, or designated aspects of the license. The RSOs of both campuses, the Director of EH&S, and the Authorized Users will comprise a Radiation Safety Committee to ensure ALARA and discuss safety and policy related to radioactive materials. Currently the Margaret Saha is the Chair of the Radiation Safety Committee.

### **Authorized, Restricted, and Supervised User Status:**

There are three levels of User Status (described below) in the William & Mary radiation safety program.

#### **Authorized User Status**

The RSO and Authorized Users are identified in this manual as a component of the VRMP License. A person designated as an "Authorized User" may possess and use radioactive material and may also purchase such material in accordance with VRMP and William & Mary policy. The Authorized User bears responsibility for the proper maintenance of radioactive materials under his/her authorization and is directly accountable for its proper usage. Granting of this status by the RSO (confirmed by the Provost) will require sufficient evidence of both formal and "on the job" training and must also be approved by license amendment from the VRMP. Application for Authorized User status and license amendment must be coordinated by the RSO. Authorized Users are responsible for retaining and producing all documentation related to their use of radioactive materials. See section VI. for contact information for the RSO and all Authorized Users.

#### **Restricted User Status**

Upon submission of the completed form entitled *Application for Radioisotope User Status*, the RSO will evaluate the formal training and experience of the applicant and may grant "Restricted User" status to certain faculty or staff members. Restricted User status will allow persons approved by the RSO to use specified radioactive material under specifically approved conditions as delineated on the *Application for Radioisotope User Status* form (see section VII, Appendix A). Restricted Users may lack the breadth of training and the years of experience to qualify as Authorized Users, but they will have demonstrated specific and extensive training in the particular procedures that have been approved by the RSO as well as mastery of these procedures. Restricted Users will be supervised by an Authorized User in an on-going way although the physical presence of the Authorized User will not be required at all times. With prior and specific approval of the RSO, a Restricted User may directly supervise previously approved procedures undertaken by "Supervised Users," as defined below. All Restricted Users must successfully complete the full version (Level I) of the William & Mary Radiation Safety Course (or an RSO-approved equivalent) at least once each year to maintain their status. They will also be required to demonstrate their expertise in handling radioactive isotopes with a practical exam. Restricted Users are responsible for retaining and producing all documentation related to their use of radioactive materials. In addition, given that an approving signature from the RSO is required for purchase of radioactive materials, RSO alternates may be appointed to allow the RSO to purchase radioactive materials.

#### **Supervised User Status**

A Supervised User will operate under direct supervision of an Authorized User or a specifically approved Restricted User. Direct supervision entails the Authorized User or the Supervised User being in the same room or building as the Supervised User. The only exceptions are if the Supervised User is working with a legally exempt amount of radioactive material as defined by the NRC/VRMP. A "Supervised User" must also complete the *Application for Radioisotope User Status* form to specify the nature of the work to be accomplished, the isotope(s) and amounts to be used, the location of the work and the name of the Authorized or Restricted User who will supervise the work. Status as a Supervised User will require the successful completion of the William & Mary Radiation Safety Course each year in addition to providing evidence that the Supervised User is proficient in the handling of radioactive material.

### **3. TRAINING:**

There are two broad categories of training based on the type of radioactive material being used, training for unsealed sources and training for sealed sources. For each category there are also two levels of training, training for those that will use the materials, and training for those who will enter areas in which the radioactive materials are being used (but not use the materials themselves).

## TRAINING FOR UNSEALED SOURCES

All persons who work with radioactive materials or frequent a designated (unsealed) radioisotope work area in a manner that can expose them to unsealed radioactive materials must successfully complete Radiation Safety training at least once per year. Two levels of training, each tailored to usage or the degree of possible exposure, will be offered.

(Level 1). Faculty, staff, and students who will work with radioactive materials will take a rigorous radiation safety course. Depending upon demand, this course may be offered at the beginning of the Fall, Spring, and Summer academic sessions by the RSO and/or Authorized User designees, and will contain specific instruction both in the theory and practice of the safe handling of radioactive materials. Specifically, this course will include instruction in the contents of this manual and a discussion of safe working practices with all licensed isotopes. This course will entail a review of area and personal monitoring, survey methods, safe handling methods, record keeping and other practices as they may be defined by the RSO. Records of attendance in the course and evidence of subject mastery through a written and/or practical exam will be collected and maintained by the RSO for at least five years.

(Level 2). Faculty, staff, and students who work in or frequent areas designated for the use of radioactive materials (but do not work with radioactive materials) will complete yearly instruction on general safety related to the use of radioactive materials. They will be instructed in: the nature of the radioactive isotopes they may encounter; how to assay for the presence of radioactive isotopes; personal protection; general safety measures; and what to do in the event of potential exposure or spill. The RSO will keep a record of this training.

## TRAINING FOR SEALED SOURCES

All persons who work with radioactive materials or frequent a designated (unsealed) radioisotope work area in a manner that can expose them to sealed radioactive materials must successfully complete Radiation Safety training at least once per year. Two levels of training, each tailored to usage or the degree of possible exposure, will be offered.

(Level 1). Faculty, staff, and students who will work with sealed radioactive materials will take a rigorous radiation safety course. Depending upon demand, this course may be offered at the beginning of the Fall, Spring, and Summer academic sessions by the RSO and/or Authorized User designees who possess expertise in sealed sources, and will contain specific instruction both in the theory and practice of the safe handling radioactive materials. Specifically, this course will include instruction in the contents of this manual and a discussion of safe working practices with all licensed sources. This course will entail a review of area and personal monitoring, survey methods, safe handling methods, record keeping and other practices as they may be defined by the RSO. Records of attendance in the course and evidence of subject mastery through a written and/or practical exam will be collected and maintained by the RSO for at least five years.

Persons working only with sealed sources may be exempted by the RSO from the annual Radiation Safety Course only if they have equivalent and up-to-date Jefferson Laboratory Radiation Safety Worker I (or II) certification.

(Level 2). Faculty, staff, and students who work in or frequent areas designated for the use of sealed sources (but do not work with the sources themselves) will complete yearly instruction on general safety related to the use of radioactive materials. They will be instructed in: the nature of the radioactive isotopes they may encounter; how to assay for the presence of radioactive isotopes; personal protection; general safety measures; and what to do in the event of potential exposure or leak. The RSO will keep a

record of this training.

#### **4. APPROVAL OF PROJECTS**

Only Restricted and Authorized Users can submit projects involving radioactive materials for approval. Each investigator who qualifies as a Restricted or Authorized User will submit to the RSO a detailed written description of all proposed activities involving radioisotopes prior to the initiation of such activities. The RSO will submit projects for approval to an Authorized User. If these activities change during the course of the year, the Restricted or Authorized User must submit an updated protocol revision. Additionally, the RSO will evaluate the radiological safety aspects of all proposed activities involving the use of radioisotopes at least annually.

#### **5. DESIGNATION OF RADIOACTIVE WORK AREAS FOR UNSEALED AND SEALED SOURCES**

Appropriate work areas in which radioactive isotope work may be conducted are designated by the RSO and approved by the VRMP. Approval of a project is contingent upon the availability of adequate laboratory facilities for assignment as work areas. As of **May 2025**, the approved areas for sealed and unsealed radioisotope source work are:

- Small Hall rooms 023, 037 (storage), and 143
- McGlothlin-Street rooms 301/301A
- Integrated Science Center Rooms 0036 (Decay in Storage closet), 0222, 3030, 3034, 3040, 3044 (cold room), 3062, 3063 (Radiation Lab).

Sealed sources are kept in a steel "KeyTrak" system in Small Hall 037. This system secures the sealed sources in the current inventory inside individual compartments that are accessed with a finger print scan of the individual Authorized or Restricted User (or EH&S Director) who must have a written protocol on file with the RSO. Each checked-out source is used only in accordance with a specific RSO-approved protocol which identify all details concerning the in-use location, the nature of the work to be accomplished (often calibration of instrumentation), safety protocols with survey requirements, and the provisions for secure source storage while the source is kept outside of the KeyTrak storage locker. Sealed sources are checked back in and secured in the KeyTrak system by the approved personnel when not in regular use.

#### **6. PROCUREMENT OF RADIOACTIVITY**

No requisition or purchase order for any radioactive substance will be accepted for purchase by William & Mary unless specific written approval for that purchase is granted by the RSO. This entails the completion of a *Radioisotope Purchase Request* form (see Section VII, Appendix A). If the RSO wishes to submit an order, he/she must first obtain approval from one of the RSO-alternates or Authorized Users.

#### **7. RECORD KEEPING AND INSPECTION**

The RSO and Authorized Users will ensure that proper records are kept regarding the status of the VRMP license and all categories of users, as well as the acquisition, use, and the disposal of radioactive material. In addition, the RSO and Authorized Users will ensure that proper surveys of work areas and personnel are performed and that adequate records are kept of these surveys as outlined in section IIIC-IIIG. All of the above records shall be kept pursuant to VRMP regulations for at least five years.

### **II. BASIC STANDARDS OF MAXIMUM PERMISSIBLE RADIATION EXPOSURE**

Current standards shall in all cases supersede those listed below.

(All excerpts below are taken from 10CFR20.1201 to 20.1208.)

## **A. STANDARDS FOR OCCUPATIONAL RADIATION WORKERS**

### **§ 20.1201 Occupational dose limits for adults**

(a) The licensee shall control the occupational dose to individual adults, except for planned special exposures under § 20.1206, to the following dose limits.

(1) An annual limit, whichever is the more limiting of:

(i) The total effective dose equivalent being equal to 5 rems (0.05 Sv); or

(ii) The sum of the deep-dose equivalent and the committed dose equivalent to any individual organ or tissue other than the lens of the eye being equal to 50 rems (0.5 Sv).

(2) The annual limits to the lens of the eye, to the skin of the whole body, and to the skin of the extremities, which are:

(i) A lens dose equivalent of 15 rems (0.15 Sv), and

(ii) A shallow-dose equivalent of 50 rem (0.5 Sv) to the skin of the whole body or to the skin of any extremity.

(b) Doses received in excess of the annual limits, including doses received during accidents, emergencies, and planned special exposures, must be subtracted from the limits for planned special exposures that the individual may receive during the current year (see § 20.1206(e)(1)) and during the individual's lifetime (see § 20.1206(e)(2)).

(c) When the external exposure is determined by measurement with an external personal monitoring device, the deep-dose equivalent must be used in place of the effective dose equivalent, unless the effective dose equivalent is determined by a dosimetry method approved by the NRC. The assigned deep-dose equivalent must be for the part of the body receiving the highest exposure. The assigned shallow-dose equivalent must be the dose averaged over the contiguous 10 square centimeters of skin receiving the highest exposure. The deep-dose equivalent, lens-dose equivalent, and shallow-dose equivalent may be assessed from surveys or other radiation measurements for the purpose of demonstrating compliance with the occupational dose limits, if the individual monitoring device was not in the region of highest potential exposure, or the results of individual monitoring are unavailable.

(d) Derived air concentration (DAC) and annual limit on intake (ALI) values are presented in table 1 of appendix B to part 20 and may be used to determine the individual's dose (see § 20.2106) and to demonstrate compliance with the occupational dose limits.

(e) In addition to the annual dose limits, the licensee shall limit the soluble uranium intake by an individual to 10 milligrams in a week in consideration of chemical toxicity (see footnote 3 of appendix B to part 20).

(f) The licensee shall reduce the dose that an individual may be allowed to receive in the current year by the amount of occupational dose received while employed by any other person (see § 20.2104(e)).

[56 FR 23396, May 21, 1991, as amended at 60 FR 20185, Apr. 25, 1995; 63 FR 39482, July 23, 1998; 67 FR 16304, Apr. 5, 2002, 72 FR 68059, Dec. 4, 2007]

#### **§ 20.1207 Occupational dose limits for minors**

The annual occupational dose limits for minors are 10 percent of the annual dose limits specified for adult workers in § 20.1201.

#### **§ 20.1208 Dose equivalent to an embryo/fetus**

(a) The licensee shall ensure that the dose equivalent to the embryo/fetus during the entire pregnancy, due to the occupational exposure of a declared pregnant woman, does not exceed 0.5 rem (5 mSv). (For recordkeeping requirements, see § 20.2106.)

(b) The licensee shall make efforts to avoid substantial variation above a uniform monthly exposure rate to a declared pregnant woman so as to satisfy the limit in paragraph (a) of this section.

(c) The dose equivalent to the embryo/fetus is the sum of:

(1) The deep-dose equivalent to the declared pregnant woman; and

(2) The dose equivalent to the embryo/fetus resulting from radionuclides in the embryo/fetus and radionuclides in the declared pregnant woman.

(d) If the dose equivalent to the embryo/fetus is found to have exceeded 0.5 rem (5 mSv), or is within 0.05 rem (0.5 mSv) of this dose, by the time the woman declares the pregnancy to the licensee, the licensee shall be deemed to be in compliance with paragraph (a) of this section if the additional dose equivalent to the embryo/fetus does not exceed 0.05 rem (0.5 mSv) during the remainder of the pregnancy.

[56 FR 23396, May 21, 1991, as amended at 63 FR 39482, July 23, 1998]

#### **B. POLICIES DESIGNED TO MINIMIZE EXPOSURE (ALARA)**

In order to implement work practices that will keep exposures to radiation "As Low As Reasonably Achievable" (**ALARA**, as defined in 10CFR20.1101), William & Mary applies to all users the standards for non-occupational workers that are 1/10 the limits of those specified above for Occupational Workers; i.e., **the maximum allowable dose to the whole body shall not exceed 0.5 rem per year**.

***All persons are expected to apply the three following principles when working with radioactive materials:***

- **TIME:** Keep the time of exposure at a minimum.
- **DISTANCE:** Keep human tissues at as great a distance from the radiation source as is practicable.
- **SHIELDING:** Keep adequate shielding materials between the source and human tissue.

### **C. ALARA PROGRAM ASSURANCE REVIEW**

At the end of each calendar year the RSOs will meet with a Provost-designated Radiation Safety Committee to review the radiation protection program content and implementation as defined in 10CFR20.1101. Pursuant to 10CFR20.2102 a report of those findings will be maintained by the Provost for a period of at least five years and will be available to the VRMP upon request.

## **III. HANDLING OF RADIOISOTOPES AND ASSOCIATED RECORD KEEPING**

### **A. DESIGNATION OF RADIOACTIVE WORK AREAS**

All areas involving the use of radioactive material must be pre-approved by the RSO and VRMP (see I-B4). Areas in which relatively high energy isotopes (such as  $^{32}\text{P}$ ) are used must be adequately shielded and clearly labeled. Areas in which lower energy isotopes are employed should be clearly designated on the area survey map for the room involved. All areas in which radioactive materials are located or are being used shall be posted with appropriate radiation hazard signs. In addition, each User shall have a copy of this manual readily accessible. A copy of sections IV, V and VI of this manual will be posted in the laboratory. Under no circumstances will food or drink be allowed in ANY room that has been approved for the use of radioisotopes. The presence of food wrappers or soft drink cans in the trash containers of areas in which radioactivity is used will be taken as evidence of food and drink in radiation usage areas. Any room with radioactive materials will have an associated map showing the location of storage and use of such materials.

### **B. PROCUREMENT OF ISOTOPES**

Acquisition of all radioactive material must be pre-approved by the RSO. The *Radioisotope Purchase Request* forms (see section VII, Appendix A) are available for the RSO or Authorized Users. No order for radioisotopes may be placed with any vendor until RSO approval is obtained. The RSO will obtain approval from an RSO-Alternate or Authorized User.

### **C. RECEIPT OF RADIOACTIVE MATERIAL**

All unsealed radioactive materials shipments must be received in the Integrated Science Center (ISC) Room 3035. An Authorized or Restricted User shall be called to inspect all incoming shipments as soon as possible after receipt according to the method pursuant to 10CFR20.1706 (below).

However, if the package appears to be leaking or damaged in any fashion, the staff person in the office will immediately contact the RSO or an Authorized User who will remove the package to a radioactive materials restricted work area and closely examine the package for leaks. In the event of a leak, the RSO must file the appropriate reports with the DOT and VRMP. If the package appears to be intact, the staff person will directly contact the Authorized User or Restricted User to check in the materials according to the procedures outlined below.

1. Put on gloves.
2. Visually inspect package for any signs of damage (e.g., wetness, crushed).
3. Measure exposure rate at 3 feet from package surface--record.

4. Measure surface exposure rate and record: If radiation in excess of 200 mrem/hour is detected at the surface in these steps, stop and notify the RSO immediately so the appropriate VRMP and carrier notifications may be made pursuant to 10CFR 71.47.
5. Open the package (following manufacturer's directions, if supplied) and remove packing slip. Open inner package to verify contents (compare requisition, packing slips, and label on bottle). Check integrity of final source container (inspect for breakage of seals or vials, loss of liquid, discoloration of packing material).
6. Wipe external surface of final source container with a 70% ethanol or isopropanol moistened cotton swab or filter paper held with forceps, assay in a liquid scintillation counter for tritium, or with a GM survey meter for higher energy isotopes. Record these readings.
7. Monitor the packing materials and packages before discarding:
  - if contaminated, treat as radioactive waste
  - if not, obliterate all radiation labels before discarding in regular trash
8. Once the isotope is properly stored, the *Radioisotope Shipment Receipt Report* must be completed as well a *Radioisotope Inventory Record* form (see Section VII, Appendix A which details subsequent isotope usage and disposal).

## **D. STORAGE OF ISOTOPES**

### **1. GENERAL PROCEDURES**

All refrigerators or freezers used for radioactive storage shall be clearly labeled with the appropriate warning sign on the door. A *Radioisotope Inventory Record* is to be posted on the door for each stock in storage in that refrigerator or freezer. Each stock container shall be labeled with the isotope, amount of activity and date, name of user, and chemical form. All radioactive isotopes will be kept in adequately shielded locations that are appropriately labeled with radioactive hazard signs. These storage areas will be secured when not in use.

### **2. STOCK SOURCES**

Radiation at the surface of the containers of any radioactive materials shall not exceed 200 mrem per hour and the container shall be kept in such a place that the radiation intensity at the nearest occupied area is 0.6 mrem per hour or less. Such containers shall be kept in a place not readily accessible to unauthorized personnel when not in use and shall be conspicuously labeled with radiation hazard signs.

### **3. GASEOUS PRODUCTS**

Radioactive gases or materials with radioactive gaseous vapors must be stored in gas tight containers, and must be kept in areas with satisfactory ventilation, preferably in approved hoods.

### **4. WASTE STORAGE**

Radioactive waste will be taken to long-term storage in Integrated Science Center Room 0036 for decay-in-storage or to await shipment for disposal. When waste in temporary storage in work areas is taken to Room 0036 it must be done under the direct supervision of the RSO or Authorized User. Before

taking the waste to Room 0036, the Authorized or Restricted User must complete the "*Room 0036 Disposal Record*" (see section VII, Appendix A) that provides detailed information on the type and amount of waste. A copy of this will be secured to the waste and another provided to the RSO for the permanent record. Arrangements to transfer such waste must be made in advance with the RSO to ensure that all records are complete.

## **E. USE OF RADIOACTIVE MATERIAL AND ROUTINE SURVEY PROCEDURES**

### **1. SURVEY OF WORK AREAS**

Radioactive material will be used ONLY in pre-approved areas and rooms (see I-B5) that are appropriately labeled and shielded. All glassware and equipment used in experiments with radioactive materials shall be labeled with radioactive warning tape and kept separate from other equipment and not be used for other work until demonstrated to be free of contamination. Immediately following a procedure involving radioactive material, the laboratory area, as well as any equipment used, will be surveyed for the presence of radioactivity and the results of the survey recorded on the *Radiation Survey Report* (see Section VII, Appendix A) appropriate for that work area.

The survey will consist of one of the following:

- a. A measurement of radiation levels with a survey meter sufficiently sensitive to detect 0.1 mrem/hr.
- b. A series of swipe tests to measure contamination levels. This method for performing swipe tests will be sufficiently sensitive to detect 100 cpm above background. Routine swipe tests will be made with either commercially prepared alcohol wipes or with Kim-wipes (or similar brand) saturated with 70% ethanol having a surface area of approximately 1 in<sup>2</sup> (6.23 cm<sup>2</sup>). A swipe will cover an area of at least 100 cm<sup>2</sup>. The swab will be counted in the liquid scintillation counter (LSC) to an error no greater than 20%. A record will be kept of all survey results on the *Radiation Survey Report*, recorded in disintegrations per minute (dpm), including negative results. These Reports shall be retained for at least five years.

The record will include:

- a. Location, date, and type of equipment (include monitor number) used to perform the survey.
- b. Name of person conducting the survey.
- c. Measured contamination levels, keyed to location on drawing (point out levels that require corrective action).
- d. Corrective action taken in the case of contamination or excessive exposure rates, reduced contamination levels or exposure rates after corrective action, and any appropriate comments.

All areas or equipment which are above background must be: (a) decontaminated or; (b) contained in a designated shielded radioactive area which is adequately labeled as such, and which poses no significant levels of exposure to personnel working in the area. Any significant contamination of any surface which cannot be cleaned and which is not in a designated shielded radioactive area shall be reported to the RSO. An area which emits over 2.0 mrems per hour is seriously contaminated and personnel must not work in the area until it is decontaminated under the direction of the RSO.

## 2. CALIBRATION OF SURVEY METERS AND LIQUID SCINTILLATION COUNTER

Annually all survey meters will be calibrated for linearity of response at two points separated by 50% of the scale for each scale in use. The counting efficiency for each isotope in use shall also be determined using sources of known activity. Each survey meter is to be checked regularly with the operational check source. The counting efficiency of the liquid scintillation counter should be checked at the time of each survey using the appropriate reference standards. A report of the calibration of all instruments is kept as a part of the RSO records pursuant to 10 CFR20.1501.

## 3. PERSONNEL MONITORING/BIOASSAYS

Iodine-125 (or 131). Between 24 and 36 hours following work with more than 1 mCi, each person involved will provide a urine specimen. The RSO will assay 3.0 ml of urine in 7 ml of scintillation fluid on a liquid scintillation counter programmed for detection of this isotope. If any specimen counts above background (+/- the statistical counting error) are determined for a person, an immediate referral of the person will be made to the Radiation Safety Office, Medical College of Virginia, Richmond, (or another equivalently equipped and staffed facility) so that a whole thyroid scan may be made. The results and the recommendations of the consulting Health Physics/Radiation Safety Office will be kept as part of the record. It will be the responsibility of the RSO to notify the subject of the dose acquired and to outline appropriate actions to minimize subsequent exposure.

Phosphorus-32. Hands, face and body will be monitored with a G-M survey meter after use. If contamination is found, urinalysis will be performed at 24 hours. If activity is detected, further urinalyses will be performed daily. If any of the procedures in a designated work area involve the use of more than 100 microcuries of Phosphorus-32 in a 24 hour period, the user concerned must wear a clip-on dosimeter approved by the RSO. These devices must be obtained prior to commencing work. Reports of any exposure indicated by these devices are maintained by the RSO and provided regularly to the user concerned.

Hydrogen-3 (tritium). In laboratories where the amount of radionuclide used is greater than 10mCi, all workers will have a urinalysis not more than one month prior to work, urinalyses will be made at two-week intervals thereafter during periods when tritium is in use.

Carbon-14, Phosphorus-33, and Sulfur-35. In laboratories where the amount used is greater than 1mCi, all workers will have one urinalysis prior to beginning work with biweekly urinalyses during its use, and one urinalysis within one month after termination of use of the radionuclide.

## 4. PERSONNEL MONITORING – EXTERNAL RADIATION

If an individual suspects that he or she has received an overexposure of external radiation from any source, he/she should immediately inform the RSO for reference to appropriate medical services. The exposed worker should be removed from areas in which he/she might receive more radiation and should not be allowed to return to work in such areas until authorized by RSO following medical evaluation. The results of all personnel monitoring will be retained by the RSO for a period of at least five years.

## **F. DISPOSAL OF RADIOACTIVE MATERIAL**

### **1. GENERAL RULES**

Radioactive waste shall not be disposed of by the conventional methods of disposing of non-radioactive waste material. This means that contaminated liquid wastes may not be discharged into the sink. Contaminated animals should not be incinerated in general purpose incinerators. Radioactive warning labels must be removed or obliterated prior to disposal in a radioactive waste container (see below). Transport of isotopes between work areas shall be accomplished in a manner that precludes exposure to any person.

### **2. RADIOACTIVE WASTE CONTAINERS**

Every laboratory using radioactive isotopes must have at least one container for contaminated solid waste and one for contaminated liquid waste for each isotope being used. Isotopes may be combined, when necessary (e.g. for double labeling experiments), but such waste must be clearly labeled as such. Solid (e.g.  $\leq$  1.5 ml of liquid in a microfuge tube) and liquid contaminated waste shall be kept separately. The container for solid waste must be lined with a sturdy disposable liner. For liquid wastes other than scintillation fluid, glass jugs or carboys are suggested for storage, although disposable metal cans may be used. If made of glass or ceramic, it must be kept in such a place that if accidentally broken, the contents will be retained in a small area (e.g., set in a large pan). For scintillation fluid wastes, fluids will be disposed of in the designated waste containers in the fume hood in Integrated Science Center Room 3063 and disposal recorded on the log sheet. Empty vials with low cpm will be placed in the fume hood for washing, Empty vials with high cpm will be disposed of in the User's laboratory in an appropriately lined (and labeled) container with a lid that fits securely. Each waste container must be labeled with a radioactive materials hazard sign and be adequately shielded. Maintenance employees (janitors, etc.) must be instructed never to empty them. A precise record of the disposal of all radioactive waste (which includes the type of isotope, the activity date, the amounts disposed in solid and liquid waste and the date of disposal) will be kept by each Restricted and Authorized User and provided to the RSO as requested.

### **3. ULTIMATE DISPOSAL**

All radioactive waste will, with the authorization of the RSO, be regularly deposited in the appropriate containers in Integrated Science Center Room 0036 where it will be left to decay in storage or be processed for disposal by a licensed commercial firm. All isotopes with half-lives of less than 120 days will be left to decay in Room 0036 for at least ten (10) half-lives. If radiation levels are at background as judged by G-M Survey Meter monitoring for solid waste and liquid scintillation counting for liquid waste, the waste will be disposed of in the regular trash after the removal and/or obliteration of all labels. If radiation levels are above background, the waste will be left to decay until levels reach background.

All isotopes with half-lives longer than 121 days will be disposed of by a licensed commercial firm. All radioactive waste deposited in these containers must be accompanied by a completed *Room 0036 Disposal Record* that records the type of isotope, the activity date, the initial activity as well as the present activity.

## **G. RECORD KEEPING FORMS**

Specific forms for various aspects of Radiation Safety record keeping are available from the RSO and Authorized Users. It is the responsibility of each User to keep records on the appropriate forms and to provide the RSO with regular updates of isotope inventory, monitoring of facilities and personnel. A list of available forms is given below (see Section VII, Appendix A):

1. *Application for Radioisotope User Status*;
2. *Radioisotope Purchase Request*;
3. *Radioisotope Shipment Receipt Report*;
4. *Radioisotope Inventory Record*
5. *Room 0036 Disposal Record*;
6. *Radiation Survey Report*;
7. *Declaration of Pregnancy Form*

To avoid tampering or loss, the RSO shall keep safely archived all completed records listed above and shall have access to all current records kept in each work area for at least five years.

#### **IV. EMERGENCY PROCEDURES**

##### **A. MINOR SPILLS FROM UNSEALED CONTAINERS:**

1. NOTIFY: Notify persons in the area that a spill has occurred.
2. PREVENT THE SPREAD: Cover the spill with absorbent paper.
3. CLEAN UP: Use disposable gloves and handling tongs. Carefully fold the absorbent paper and pad. Insert into a plastic bag and dispose of in a radioactive waste container. Include all other contaminated materials such as disposable gloves.
4. SURVEY: With a G-M Survey Meter, check the area around the spill, your hands, clothing, and shoes for contamination. Do not leave the area before monitoring.
5. REPORT: Report incident to the RSO as soon as possible
6. DOCUMENT: Complete the Radioactive Spill & Contamination Survey Report

##### **B. MAJOR SPILLS OR LOSS OF SEAL- INTEGRITY IN A SEALED-SOURCE:**

1. CLEAR THE AREA: Notify all persons not involved in the spill to vacate the room.
2. PREVENT THE SPREAD: Cover the spill (or broken source container) with absorbent pads, but do not attempt to clean it up. Confine the movement of all personnel potentially contaminated to prevent the spread.
3. SHIELD THE SOURCE: If possible, the spill (or source) should be shielded, but only if it can be done without further contamination or without significantly increasing your radiation exposure.
4. CLOSE THE ROOM: Leave the room and lock the door(s) to prevent entry. Do not leave the area without first removing all potentially contaminated clothing.
5. CALL FOR HELP: Notify the RSO IMMEDIATELY.
6. PERSONNEL DECONTAMINATION: Contaminated clothing should be removed and stored for further evaluation by the RSO. If the spill is on the skin, flush thoroughly and then wash with mild soap and lukewarm water.
7. CLEANUP: The RSO will supervise the cleanup of the spill and will complete the Radioactive Spill & Contamination Survey Report.

#### **V. BASIC RULES OF RADIATION SAFETY**

1. Do not eat, drink, smoke, or apply cosmetics in any laboratory in which work with isotopes is performed. BSL1 laboratory standards must be followed for any area in which isotope work is performed.
2. Wash hands thoroughly before handling any object that will be placed in the mouth or on the face.
3. ALWAYS wear disposable gloves when working with radioactive material.
4. All work must be performed over table surfaces or trays lined with removable, absorbent paper.

5. NEVER PIPETTE RADIOACTIVE SOLUTIONS BY MOUTH. Use remote measuring devices, such as disposable syringes, or automatic pipettes with disposable tips.
6. With approval of an Authorized User, regularly discard all waste material in special labeled containers in Integrated Science Center 1, Room 0036. Solid waste containers must be separate from liquid waste containers. All waste containers must be lined with sturdy plastic bags that can be removed and all containers must have lids that fit securely.
7. All radioactive material must be contained in appropriately shielded and labeled containers.
8. All glassware which contains or has contained radioactive substances must be marked with radiation tape or radiation signs until it has been decontaminated.
9. All containers of radioactive substance, including waste, must be labeled as radioactive and must show the date and the type and activity of the isotopic material contained, with radiation level, if applicable.  
**PRIOR TO DISPOSAL OF WASTE IN THE RADIOACTIVE WASTE CONTAINER, ALL RADIOACTIVE WARNING LABELS MUST BE REMOVED OR OBLITERATED FROM THE WASTE MATERIAL.**
10. All areas in which radioactive material is used must be secured when no one is immediately present.
11. Surveys must be completed after EACH procedure and must be recorded in DISINTEGRATIONS PER MINUTE (dpm, not cpm). Records of radioisotope inventories, disposal, and area surveys must be kept current and easily accessible.

## **VI. CONTACT PERSONS**

## ***Radiation Safety Officer***

Eric L. Bradley, RSO

Office: (757) 221-2220 Cell:(757) 897-1034

### ***Authorized Users:***

Eric L. Bradley for Sealed and Unsealed sources Office: (757) 221-2220 Cell: (757) 897-1034

Margaret S. Saha for Sealed and Unsealed sources Office (757) 221-2407 Cell: (757) 876-2873

Jim Kaste for for Sealed and Unsealed sources      Office (757) 221-2951      Cell: (603) 204-7280

## ***Director, Environmental Health & Safety***

Teresa Belback for Sealed and Unsealed sources      Office: (757) 221-2146      Cell:(804) 370-3877

In the event of a radiological emergency, If unable to contact the RSO or any Authorized User, then contact the Office of Environmental Health & Safety on-call number at (757) 221-1643.

## **VII. APPENDIX A – FORMS**

1. *Application for Radioisotope User Status*

**APPLICATION FOR RADIOISOTOPE USER STATUS**

**Part I:**

Name: 93 Number:

Date:

Position (e.g. student, technician ...):

Formal Training:

Describe in detail type(s), date(s) and place(s) of training.

On the Job Experience:

List the type of isotope, amount used, the specific application, the dates and frequency of use, and the institution.

**Part II:**

Please describe in detail all proposed activities involving radioisotopes. This should include the location of the work area, the type of isotope, the amount to be used in each type for experiment and the specific application. *This should be in agreement with the paperwork that your PI already has on file.*

I have read and understood (and know) the contents of the Department of Radiation Safety Manual and I understand the provisions of the referenced NRC documents.

Signature: \_\_\_\_\_ Date: \_\_\_\_\_

**Part III: (to be filled out the by Supervising PI).**

Please describe any activities for which the user (e.g. student or tech) is authorized to work without direct supervision, that is, the PI within shouting for help distance.

Signature of PI: \_\_\_\_\_ Date: \_\_\_\_\_

## 2. Radioisotope Purchase Request

**RADIOISOTOPE**

PURCHASE REQUEST #\_\_\_\_\_ NAME\_\_\_\_\_

ACCOUNT#\_\_\_\_\_

**VENDOR:****VENDOR ADDRESS:****VENDOR PHONE:****Customer #:****FIN #:****Confirmation #:****SHIP TO:**

The College of William &amp; Mary

540 Landrum Drive

Room 3035

Williamsburg, VA 23185

**REQUISITION BY:**\_\_\_\_\_**CUSTOMER SVC REP**\_\_\_\_\_**DATE**\_\_\_\_\_ **TIME**\_\_\_\_\_

NO.	Q T Y	UNIT	CATALOG #	DESCRIPTION	PRICE	AMOUNT
1						
2						
3						

**Describe the radioisotope protocol(s):****Laboratory PI:**\_\_\_\_\_

---

**RADIATION SAFETY OFFICER****DATE:**

### 3. Radioisotope Shipment Receipt Report

#### RADIOACTIVE SHIPMENT RECEIPT REPORT

PO # \_\_\_\_\_ Survey Date \_\_\_\_\_ Time \_\_\_\_\_

Vendor \_\_\_\_\_ Survey by: \_\_\_\_\_

**Condition of package on receipt:**

Intact: \_\_\_\_\_ Broken or Damaged: \_\_\_\_\_ Describe damage \_\_\_\_\_

Shipping package radiation levels: At the Surface \_\_\_\_\_ mR/hr

3 feet from Surface \_\_\_\_\_ mR/hr

GM Survey meter used: \_\_\_\_\_ Calibration Date: \_\_\_\_\_

**PACKAGE CONTENTS DETAIL**

Radioisotope \_\_\_\_\_

Chemical Form \_\_\_\_\_

Amount \_\_\_\_\_ uCi

Describe any discrepancies between packing slip and package contents:

If DOT/NRC/ Carrier notification is required enter details here:

---

**SURVEY OF OPENED PACKAGE AND PRIMARY CONTAINER**

Survey with *GM survey meter* if the radioisotope is Iodine 125, Iodine 131, or P32

Record the activity: Packing Material \_\_\_\_\_ mR/h Primary Container \_\_\_\_\_ mR/h

GM Survey meter used: \_\_\_\_\_ Calibration Date: \_\_\_\_\_

-----OR-----

If the isotope is H3, C14, S35, or P33 then conduct wipe tests on the shipping container and the primary container with 70% ethanol or isopropanol using *liquid scintillation counting*.

Shipping Package: \_\_\_\_\_ CPM \_\_\_\_\_ DPM

Primary Container: \_\_\_\_\_ CPM \_\_\_\_\_ DPM

Final disposition of the shipping package:

#### **4. Radioisotope Inventory Record**

## RADIOISOTOPE INVENTORY RECORD

Isotope \_\_\_\_\_ Vendor \_\_\_\_\_  
Date Received \_\_\_\_\_ Purchase Order # \_\_\_\_\_  
Activity Date \_\_\_\_\_ Lot # \_\_\_\_\_  
Specific Activity \_\_\_\_\_ Storage Room \_\_\_\_\_  
Total Volume \_\_\_\_\_ Location in Room \_\_\_\_\_  
uCi/uL \_\_\_\_\_

## RECORD OF USE

## RECORD OF DISPOSAL

## **Solid Waste****Liquid Waste**

**5. Radiation Survey Report****RADIATION SURVEY REPORT**

ROOM # \_\_\_\_\_

All recordings must be in DPM (not CPM).

For all liquid scintillation wipe test results apply the appropriate efficiency correction for the isotope in use. Correct the CPM readings from a GM Survey meter with the efficiency recorded on the meter. As necessary, attach a map of the room to indicate the location of bench areas, refrigerators, freezers, and other items that are not identified by name.

	DATE	DATE	DATE	DATE
(Edit form as needed for room,)	GM #	GM#	GM#	GM#
ITEM	NAME	NAME	NAME	NAME
Refrigerator 1				
Refrigerator 2				
Freezer 1				
Ultracold				
Centrifuge				
Water bath				
Pipetman				
Bench 1				
Bench 2				
Sink				
Telephone				

## 6. Room 0036 Disposal Record

Activity Date: Isotope: Liquid / Solid

### ISC ROOM 0036 DISPOSAL RECORD

Date of Disposal in Room 0036:

Name of Restricted/Authorized User:

Name of PI:

Name of Person Completing Sheet:

Isotope and Company:

Purchase Order Number:

Lot Number:

Activity of disposed material, as of the activity date of the isotope:

(to be calculated from Inventory Record)

Current Activity (decay corrected for  $^{35}\text{S}$  and  $^{32}\text{P}$ ) as of Room 0036 disposal date:

Make three copies of each sheet, one to be attached to the waste bag, one to be given to the RSO, and one for the PIs records)

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### FINAL DISPOSAL RECORD

Date of Final Disposal:

Number of half-lives (for decay-in-storage isotopes only):

Method for confirming material is at background level for decay-in storage isotopes only (e.g. scintillation counting, GM survey):

Results of counting or survey: Your initials:

Method of Disposal (sanitary sewer, dumpster, commercial pickup):

**7. Declaration of Pregnancy Form**

DECLARATION OF PREGNANCY

TO: Radiation Safety Officer  
College of William & Mary

In accordance with Nuclear Regulatory Commission regulations at 10 CFR 20.1208, "Dose to an Embryo/Fetus," I am declaring that I am pregnant. I believe that I became pregnant in

\_\_\_\_\_ (Month/Year).

I understand that the radiation dose to my Embryo/Fetus during the entire pregnancy will not be allowed to exceed 0.5 Rem (5 millisievert) unless that Dose has already been exceeded between the time of conception and the submission of this document. I also understand that meeting the lower dose Limit may require a change in my job or job responsibilities during the period of my pregnancy.

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Printed Name

\_\_\_\_\_  
Date

## 8. Radioactive Spill & Contamination Survey Report

## **RADIOACTIVE SPILL & CONTAMINATION SURVEY REPORT**

Date and Time of Spill:

### Building and Room:

**Principal Investigator:**

Department:

### Personnel Present:

### Isotope:

Total amount of radioactive materials working with:     $\mu\text{Ci}$

Estimated amount of spilled materials ( $\mu\text{Ci}$ ):

### Grid of concentrated spill area:

*Numbered to match surveyed areas*

### **Survey BEFORE decontamination**

#	Area Surveyed	mR/hr	DPM
1			
2			
3			
4			
5			
6			
7			

### **Survey AFTER decontamination**

#	Area Surveyed	mR/hr	DPM
1			
2			
3			
4			
5			
6			
7			

Completed by: \_\_\_\_\_  
Print Name

---

Signature

Date: \_\_\_\_\_