University of Puerto Rico
Medical Sciences Campus (MSC)

Radiation Safety Manual

DECEMBER 2022

Preface

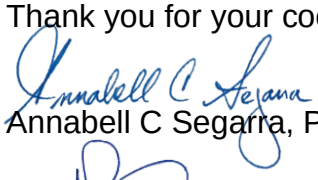
The University of Puerto Rico (UPR), Medical Sciences Campus (MSC) strives to provide a safe and healthful environment for all persons associated with the University, including faculty, staff, students, and visitors. Attainment of this goal requires the cooperation and commitment of all people involved.

The University emphasizes safety education and training as the primary means of achieving this goal. The Radiation Safety Office is responsible for radiation safety functions within the University, providing training and performing periodic safety inspections. The department chairs, faculty members, and supervisors are directly responsible for maintaining an atmosphere that promotes full compliance with the MSC safety policies and procedures. About radiation safety matters, the Radiation Safety Committee, appointed by the Chancellor of the MSC, establishes radiation safety policies and procedures for the University in accordance with requirements set forth by State and Federal regulatory agencies. Responsibility for overseeing compliance with these policies and procedures rests with the Radiation Safety Officer.

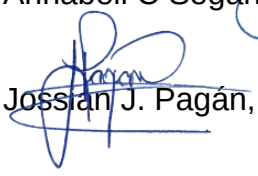
Essential elements of the University's radiation safety program are presented in this Radiation Safety Manual. The radiation safety program has been carefully developed to allow all radiation users to participate in utilizing the unique advantages of radiation sources while meeting all safety standards in an efficient and non-intrusive manner. A good radiation safety philosophy is to maintain all exposures at levels as far below regulatory limits as can reasonably be achieved. The University strongly supports this "As Low As Reasonably Achievable" (ALARA) safety goal. The policies and procedures found in this manual were designed to promote the achievement of this goal, and to comply with 10 CFR 20.1101 (a)(b) “Radiation Protection Programs” and 20.2102 “Records of Radiation Protection Programs”.

In this era of increasing concern for occupational safety and for the environment, it is essential that all members of the University community become and remain familiar with their responsibilities for compliance with health and safety regulations, including these radiation safety policies and procedures. Please study the contents of this manual. Know and practice these and all other safety rules. The manual is a practical reference, but users must also have technical knowledge of radiation and some experience in handling radioactive materials.

Thank you for your cooperation:



Annabell C Segarra, Ph. D., Chair, Radiation Safety Committee



Jossian J. Pagán, DrPh, MS, CNMT, Radiation Safety Officer

This Radiation Safety Manual was reviewed by the Chair of the Radiation Safety Committee (RSC), Institutional Radiation Safety Officer (RSO) and the Office of Radiological Protection and Safety in Research Laboratories (OSLI) of the Administration Dean of the Medical Sciences Campus from the University of Puerto Rico, in San Juan Puerto Rico, today December 5, 2022.

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Radiation Protection Office /Safety in Research Laboratories (OSLI)

Rozaida Martínez Torres, BBA
Interim Dean of Administration

Carlos A. Ortiz Reyes, PhD(c), MBA
Interim Chancellor
University of Puerto Rico
Medical Sciences Campus

UNIVERSITY OF PUERTO RICO
MEDICAL SCIENCES CAMPUS
LOCAL AUTHORITIES FOR EMERGENCY RESPONSE

ALL EMERGENCIES EXT. 7911

MEDICAL SCIENCES CAMPUS:

- **Security Office: (787) 758-2525, ext. 1000, 1001**
  Director: Mr. William Figueroa

- **Occupational, Health, Safety and Environmental Office (CASSO):**
  (787) 758-2525, ext. 1054, 1707, 1237
  Director: Ms. Vanessa Rodríguez

- **Occupational Health Clinic (CASSO):**
  (787) 758-2525, ext. 2913
  Occupational Nurse: Ms. Juanita Rivera

- **Office for Safety in Research Laboratories (OSLI):**
  (787) 758-2525 ext. 1687, 1688, Direct # (787) 766-3062, Fax: (787) 764-6889
  OSLI Staff: Mr. Rafael Martínez, Mrs. Ivelisse Martin and Mrs. Yolanda Rodríguez
  Radiation Safety Officer: Dr. Jossian J. Pagán Lisboa

LOCAL AUTHORITIES:

- **Emergency Response Center (Llamadas de emergencia): 911**

- **Puerto Rico Police Department: (787) 343-2020, (787) 782-1050**

- **Puerto Rico Fire Department:**
  Puerto Nuevo Station- (787) 783-2331
  Río Piedras Station- (787) 754-2330, (787) 763-1170

- **Industrial Hospital, Emergency Area: (787) 754-2525 ext. 2100, 2103, 2134, 2135**

- **Emergency Management Agency: (787) 724-0124 ext. 1000**

- **Puerto Rico Medical Service Administration (ASEM): (787)777-3535, (787)777-3708 & (787)281-0570**

- **Poisoning Control Center of Puerto Rico: 1-800-222-1222**

- **Environmental Quality Board (Junta de Calidad Ambiental): 311**
  Mon thru Fri (787) 767-8181, (787) 766-0150, ext. 3234, 3220, 3230
  Sat and Sun (Emergencies regarding chemical spills) (787) 724-0124

2022 MSC RADIATION SAFETY COMMITTEE

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Abbreviations Used in This Manual

- **ALARA** - As Low as Reasonably Achievable
- **ALI** - Annual Limit on Intake
- **AU** - Authorized User
- **Ci** - Curie
- **cm2** - square centimeters
- **cpm** - counts per minute
- **DAC** - Derived Air Concentration
- **dpm** - disintegrations per minute
- **GM** - Geiger-Muller
- **NaI** - Sodium Iodide
- **kg** - kilogram
- **lfm** - linear feet per minute
- **LSC** - Liquid Scintillation Counter
- **mCi** - milliCurie
- **ml** - milliliters
- **MeV** - mega electron-volts
- **mrem** - millirem (0.001 rem)
- **MSC** – Medical Sciences Campus
- **NRC** - Nuclear Regulatory Commission
- **OHC** - Occupational Health Clinic
- **OLSR – Office of Laboratory Safety in Research**
- **PSA** - Physical Security Activity
- **RIA** - Radioimmunoassay
- **RSC** - Radiation Safety Committee
- **RSO** - Radiation Safety Officer
- **TLD** - Thermoluminescent Dosimeter
- **^{3}H** - Tritium (hydrogen-3)
- **^{14}C** - Carbon-14
- **^{32}P** - Phosphorous-32
- **^{33} P** - Phosphorous-33
- **^{35}S** - Sulfur-35
- **^{51}Cr** - Chromium-51
- **^{60}Co** - Cobalt-60
- **^{125}I** - Iodine-125
- **^{129}I** - Iodine-129
- **^{131}I** - Iodine-131
- **^{137}Cs** - Cesium-137
- **10 CFR 19** - NRC's Title 10, Chapter 1, Code of Federal Regulations, Part 19
- **10 CFR 20** - NRC's Title 10, Chapter 1, Code of Federal Regulations, Part 20

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Part 1: RADIATION SAFETY PROGRAM

I. FEDERAL REGULATIONS

A. Licenses

The Medical Science Campus, University of Puerto Rico (MSC) operates under one specific license issued by the United States Nuclear Regulatory Commission (NRC), license number 52-01946-07. It must comply with the terms of the license while using any radioisotopes that are produced as by-product materials in a nuclear reactor. The license confers authority upon the University to approve, manage and control the receipt, use and disposal of radioactive materials.

There is only one license for the entire university. For this reason, a violation to NRC regulations by any individual jeopardizes the permission of all authorized users to utilize radioactive material at the MSC. If, for any reason, the license is suspended or terminated, no individual or principal investigator may use licensed radioactive materials until the license is reinstated. Therefore, this license places significant responsibility on everyone who uses radioactive materials to conform to safe work practices, and to conduct and complete all required compliance duties, however large or small they may be.

B. Regulations

The U.S. Nuclear Regulatory Commission (NRC) is the branch of the federal government which regulates the licensing, use and disposal of radioactive materials. A multitude of laws set forth by the NRC must be obeyed. If any of the regulating agencies or authorities determine that the laws or conditions are not complied with during the periodic inspections which they conduct, violations will be cited, and penalties may be imposed. Penalties may include civil penalties (which may be fines or criminal prosecution in court), sanctions, suspension, or termination of the license. For this reason, it is imperative that all Authorized Users, workers, and support staff involved in the receipt, use, disposal, or records of radioactive materials be aware of and comply with these laws.

The Code of Federal Regulations (CFR), Title 10, Parts 19 “Notices, Instructions and Reports to Workers: Inspection and Investigations” and Part 20 “Standards for Protection Against Radiation”, are legal requirements set forth for all radioactive materials licensees. Part 20 contains the general practices, requirements, and conditions by which all users of radioactive materials must abide. On January 1, 1994, the revised Title 10 CFR, Part 20 became law for all licensees. Numerous changes were made; most of these changes pertain to the way the programs and operations are managed. The RSO and RSC have the responsibility of assuring compliance with these regulations. NRC now requires from each licensee the practice of ALARA *As Low As Reasonably Achievable”. These regulations may be viewed via the Internet at http://www.nrc.gov/NRC/CFR/index.html. Additional requirements are included in the NRC license issued to the MSC governing the possession and use of radioisotopes. Employees are encouraged to refer to these standards and the current license.

II. PROGRAM OPERATIONS

A. The Radiation Safety Program of MSC - UPR

Individuals Responsible for Radiation Safety Program

Qualified individuals of the UPR- Medical Sciences Campus as authorize users by the Radiation Safety Committee (RSC) and engaged as principal investigators and/or have significant responsibility for administrative, medical, academic, or experimental functions involving radioisotopes and can demonstrate an acceptable level of confidence in the safe handling of radioactive materials.

1. Chancellor of the UPR-MSC duties:

a. Has the authority to make prompt decisions based on the information available without having to consult with higher management officials, including the authority to take whatever action is necessary to ensure that all radiation safety practices are in accordance with the regulations.

b. Authority to appropriate funds in a timely manner for the radiation safety program significant financial needs.

c. Available to facilitate effective and immediate action on behalf of management, the RSC, and the RSO, particularly in the event of an emergency.

d. Selects an executive management representative to the RSC with a science background or an aptitude for radiation safety issues.

e. Appoint a representative who actively participates as a member of the radiation safety committee (RSC) and has the authority to delegate necessary resources to the radiation safety program, as identified by the RSC.

f. Designated representative will be available to the RSO and RSC chairperson to facilitate effective and immediate action on behalf of management or the RSO and RSC in the event of radiation safety emergency or potential emergency.

g. Completeness and accuracy of the radiation safety records, and all information provided to NRC. Knowledge about the contents of the license and application.

h. Compliance with current NRC and Department of Transportation (DOT) regulations and the licensee's operating and emergency procedures.

i. Commitment to provide adequate resources (including space, equipment, personnel, time, and, if needed, contractors) to the radiation protection program to ensure that patients, the public and workers are protected from radiation hazards. Therefore, executive management identifies resources for the RSO, and the radiation support staff if indicated, to attend professional meetings.

j. Selection of a qualified individual to serve as the Radiation Safety Officer (RSO) with responsibility for the overall radiation safety program. The RSO shall have independent authority to stop unsafe operations and will be given sufficient time to fulfill radiation safety duties and responsibilities.

k. Commitment to report defects, noncompliance, or reportable events, including medical events in accordance with regulations.

l. Prohibition against discrimination of employees engaged in protected activities.

m. Commitment to provide information to employees regarding employee protection and deliberate misconduct.

n. Obtaining NRC's prior written consent before transferring control of the license.

o. Notifying appropriate NRC regional administrator in writing, immediately following filing of petition for voluntary or involuntary bankruptcy.

2. Radiation Safety Committee (RSC) duties:

The Radiation Safety Committee (RSC) has the responsibility of establishing a Radiation Safety Program that ensures the safe use, management, storage, and disposal of radioactive material in areas under the control of the University of Puerto Rico Medical Sciences Campus (UPR, MSC). This includes the Dr. Guillermo Arbona Building (Main Campus at the Medical Center), Nuclear Medicine Laboratory at Dr. Isaac González Martínez Hospital and the Radiation Protection Office at the Cancer Comprehensive Center. The RSC must ensure compliance with federal regulations, including those of the U.S. Nuclear Regulatory Commission (NRC) as well as safeguard the environment.

The RSC, as required by NRC regulations and by conditions of UPR MSC Broad Scope License, maintains oversight of all operations involving radioactive materials and radiation-producing equipment. The RSC and the RSO advise the Administration on matters relating to radiation safety and compliance with NRC regulations. The RSC is appointed by the Chancellor of UPR MSC. The duties, membership and organization of the RSC are provided below.

a. Determine the adequacy of the training and experience of Authorized Users (AU) to possess and use radioactive material and radiation sources under the MSC-UPR material license. Evaluate the training and experience requirements of applicants that request authorization to use radioactive material at the MSC-UPR. Also review each proposal, protocol for using radioactive material, general design of facilities, personal protective equipment, surveys for removable contamination, waste disposal etc., to ensure that all procedures are in accordance with good radiation safety practices and regulations for RSC approval.

b. Evaluate and finally grants the formal approval of proposed new users and new uses of byproduct material. Thoroughly review the overall compliance status for AU.

c. Evaluate and approve modifications to existing uses to an AU’s license material.

d. The RSC Chairperson and the RSO must sign all Radioactive Material Licenses and amendments.

e. Review and approve of policy or procedural changes to the radiation safety program.

f. To approve a new policy or procedure, a simple majority of a quorum of the RSC is required prior to authorization. The approved change will be documented and will state the reason for the changes and summarize the radiation safety matters that were considered prior to approval of the change. The RSC oversees the implementation of the change including training of personnel and audits to ensure compliance.

g. Ensures that the material possessed under the broad scope program may only be used by, or under the direct supervision of individuals approved by the RSC.

h. Receive, review, and take appropriate action on reports from the RSO, (e.g., areas and personnel monitoring; accidents in handling, storage, and use of radioactivity; medical events, items of non-compliance identified in audits, loss, or theft of any amount of radioactivity; records of radionuclide procurement and disposal).

i. Require cessation of any operation involving radiation upon a determination of inadequate safety procedures.

j. Participate in an annual review of the Radiation Safety Program, in collaboration with the RSO based on radiation protection principles to achieve doses that are ALARA and provide any necessary recommendations to ensure this.

k. Conducts periodic audits to the Radiation Safety Program with the RSO. This includes the review of all records, visits to the locations where radioactive material is authorized to be use, the reports from the RSO, (e.g., area monitoring; personnel monitoring; accidents in handling, storage, and use of radioactivity; items of non-compliance identified in audits, loss or theft of any amount of radioactivity; records of radionuclide procurement and disposal). Also, the results of NRC inspection, written safety procedures, the adequacy of the institution's management control system will be reviewed when necessary.

l. Review the Radiation Safety Program based on radiation protection principles to achieve ALARA and analyze possible trends and determine the course of corrective action(s) to be taken.

m. Advise the MSC-UPR Administration regarding matters of radiation protection.

n. Provides technical oversight, advice, and assistance to the Administration and the Radiation Safety Office on matters concerning radiation safety and security.

o. Meets at least quarterly to review radiation safety issues and receive a status report on such issues from the RSO. The Chair of the RSC has the authority to make temporary policy decisions when a formal RSC meeting cannot be scheduled in a timely fashion. Such temporary policy decisions are subject to full review by the RSC at its next meeting. Written minutes are kept for regulatory audits.

p. The RSC chairperson has direct line of communication with the Chancellor to discuss radiation safety issues that need to be brought to management’s attention.

q. Institutional AU license termination will be produced by the RSC when health and safety of employee, property and environment appears to be compromised with repeated violations to radiation safety regulations and/or user's responsibilities.

3. Membership and Organization of the RSC:

The Radiation Safety Committee shall be appointed by the Chancellor of UPR MSC. The RSC shall include: (1) the Radiation Safety Officer; (2) the Chair of the RSC and (3) a representative from the Administration. Additional members will consist of Authorized Users and radiation workers trained and experienced in the safe use of radioactive materials representing each type of use such as nurses, nuclear medicine technologist and occupational health employees. The Committee shall have members with expertise on clinical use of radioactivity as well as members that conduct biomedical research with radionuclides. Members shall represent the various types of uses of radioactive materials or radiation sources throughout the MSC-UPR. The Chancellor of MSC-UPR may at her/his discretion, remove or reappoint any member of the RSC at any time. The RSC may recommend to the Chancellor the appointment of additional members to improve the effectiveness of the RSC.

The Chairperson calls and presides over all meetings, establishes agendas, maintains close communication with the RSO, the Radiation Safety Office and the Administration. He/she will inform the Chancellor of important matters pertaining to the Radiation Safety Program. The Chairperson also establishes working groups and appoints ex-officio

members to the Committee, as the Committee deems necessary. During a leave of absence, a member of the RSC will be nominated to serve as interim Chairperson of the RSC.

The Administrative Assistant of the RSC, records the minutes of all meetings and maintains official RSC files. The Administration shall provide administrative support to the Committee. Meetings shall be conducted at least four times a year at three-month intervals. A quorum will be satisfied with half the members plus one, including the chairperson and the RSO or Deputy RSO (his designee).

4. Radiation Safety Officer (RSO) duties:

The RSO is a professional and a qualified individual by training and experience in radiation protection assigned by the Chancellor of the MSC-UPR to serve as the Radiation Safety Officer (RSO) with responsibility for the overall radiation safety program and compliance with the regulations for the use of byproduct material. The RSO reports to top management, the Administration Representatives, and the RSC. The RSO has access to all levels of the organization and has the authority to terminate any activity in which health and safety appear to be compromised. The RSO has no disciplinary authority which shall reside instead with the Dean of Administration or the Chancellor.

The RSO has sufficient time and commitment from management to fulfill certain duties and responsibilities to ensure that radioactive materials are used in a safe manner. Therefore, the RSO manages the day-to-day operations of the Radiation Safety Program and assures compliance with the MSC-UPR policies and procedures and with the NRC rules and regulations to adequately protect public health and safety and maintain exposures ALARA. The RSO will have access to all activities involving the use of byproduct material.

In an emergency, a designee of the RSO or of the RSC (Chair) may act for the when necessary to control or prevent an incident involving radioactive materials. This also may include the temporary ordering of cessation of laboratory operations or withholding authority to purchase or use isotopes until the RSC reviews these infractions. The RSO and the RSC have sufficient authority, organizational freedom, and management prerogative to accomplish these goals. These responsibilities and authorities are limited to those served under NRC license num. 52-01946-07.

The duties of the RSO includes:

a. Consulting with members of the RSC and Authorized Users (AU) on all matters relating to the use of radioactive materials.

b. Assuring compliance with the regulations and rules of the NRC and the MSC-UPR broad scope license to procure, use, store, secure, and dispose of radioactive materials through monitoring and periodic formal and unannounced inspections.

c. Developing and implementing procedures for periodic radiological surveys; ordering, receiving, and distribution of radioactive materials; and use of sealed radioactive sources.

d. Overseeing the waste disposal program and any decontamination process.

e. Assist in the packaging, labeling, surveys process of all shipments of byproduct material leaving the Institution.

f. Monitoring inventory and leak tests of sealed sources

g. Monitoring personnel exposure records and developing corrective actions for those exposures approaching maximum permissible limits.

h. Performs audits where byproduct material is used to ensure work is done in accordance with regulations and permit conditions.

i. Developing and implementing training for all personnel involved in handling radioactive materials. Assuring that personnel receive periodic review of important procedures, rules, and methods.

j. Reviewing applications and protocols of new AU.

k. Maintaining records of procurement, area monitoring, personnel monitoring, accidents and incidents, and any other documents required by the Radiation Safety Program and NRC regulations.

l. Approving requested quotes to purchase radioactive materials. The RSO will make certain that only AU or their approved alternates place orders and will verify that these orders do not exceed the amounts approved by the RSC permit and do not exceed the established limits under MSC-UPR material license.

m. Responding to all emergencies involving radioactive materials and providing expert advice and assistance as required by the program.

n. Interacting with the NRC on issues related to the MSC-UPR licenses, amendments, renewals, and inspections.

o. Assuring compliance with all "As Low As Reasonably Achievable" (ALARA) regulations as defined by 10 CFR 20.

5. Radiation Safety Office Staff

The Radiation Safety Office, which is comprised of technicians under the direction of the RSO, is responsible for the MSC-UPR overall compliance with policies and regulations. The Radiation Safety Office also provides a variety of technical services and audits necessary to achieve such compliance. The licensee will provide sufficient professional and administrative staff to assist the RSO in implementing the radiation safety program. The licensee will evaluate the licensed program and ensure that the RSO has adequate resources to effectively manage the program.

The Radiation Safety Office is also known as the Office of Laboratory Safety in Research (OLSR). This Office has the overall responsibility to oversee the safe use of biological, chemical, and radioactive material in biomedical research laboratories and nuclear medicine lab of the MSC-UPR. Currently the RSO also serves as the Director of the Office of Laboratory Safety in Research. The Director of OLSR reports to the Dean of Administration.

B. Physical Security of Radioactive Materials

1. Requirements of the RSC and the RSO for authorizing new users and new uses:

The investigator must apply for the use of radioactive material and complete one of the following forms: Application Form for Nuclear Medicine or Application Form for Biomedical Research. The form must be submitted to the RSC for evaluation and approval as authorized users (AU) for the use of radioactive material or radiation sealed sources in the promises of the MSC-UPR. The required documents and forms for application will be available at the RSC link: https://committees.rcm.upr.edu/rsc/.

The applicant will submit a complete protocol describing his research plan to include its rationale, background, methods, and a description of measures employed to minimize radiation exposure to the experimenter, any human subjects, and the protection of the environment. Also, should include the following information: description of the requested material and quantity to be used, the location and general design of facilities, surveys for removable contamination, waste disposal process, individuals who will handle the material, present evidence of training and experience of the applicant working with radioactive material, the training of workers, the personnel protective equipment to be used, and monitoring equipment.

Investigators or directors of research protocols involving uses of radioactive materials "in vitro" or animals will also have to provide the information requested in corresponding application form and fulfill the minimum experience and training. Only physicians who are licensed to practice medicine in Puerto Rico and who fulfill the experience and training requirements will be considered for routine medical use of radioisotopes.

To approve a new User, a simple majority of the quorum of the RSC is required prior to authorization. The RSO and RSC Chairperson must sign all Radioactive Material Licenses and amendments. In their absence, the license may be signed by an alternate, provided the alternate meets applicable regulatory requirements and is approved by the Radiation Safety Committee (typically another RSC member). Complete records and documents of all MSC Institutional Licenses will be filed by the Chairperson of the RSC and the originals of the Licenses will be filed in the Radiation Safety Office.

The RSC established new policies for an authorize user regarding the purchase and use of radioactive material such as:

a. To qualify for the use of radioactive materials for clinical and research purposes, the laboratory must comply with good housekeeping practices.

b. The MSC - UPR promotes the substitution of radioactive tracers for non-radioactive methodologies, such as chemiluminescent, in experimental procedures.

c. In the absence of alternative non-radioactive methods, the RSC will evaluate proposals that use short half-life radioactive isotopes.

d. Present copies of scientific literature to support the absence of alternative non-radioactive methods, or short half-life radioactive isotopes alternatives, to conduct the proposed research.

e. To obtain approval for the use of long half-life radioactive isotopes (H3, C14- with 10 half - life of 12.33 yrs and 5,730 yrs respectively, the Principal Investigator will have to provide evidence of fund availability for the disposal of the radioactive waste and unused radioactive material when the laboratory is decommissioned and when necessary.

2. Procedures for authorization or institutional permit to use and handle radioactive materials at the MSC-UPR

The RSC will approve new uses of ionizing radiation (radioactive material and machine produced radiation) by individual physicians or other scientists in clinical or research activities and any amendment to an authorized user's radioactive material license. The RSC will follow guidelines in each case. Anyone wishing an authorization or Institutional Permit must arrange an interview with the RSO to review the applicant's experimental procedures and available facilities and discuss any applicable regulations, procedures, and practices. The applicant must provide all information requested on the Application Form and submit it to the RSO for his review and recommendations to the RSC. AU must apply for new uses of ionizing radiation and submit amendments to their license for any change in experimental procedures which have an impact on safety, and for a change in chemical or physical form of a material previously approved.

a. The RSC will evaluate and approve new uses of ionizing radiation (radioactive material and machine produced radiation) and any modification to existing uses. In case of any significant change in the experiment procedures, the RSC and/or RSO will decide if a new application is recommended.

b. The AU shall renew their application form on annual basis. Failure to comply with this requirement will lead to the suspension of his institutional permit by the RSC.

c. The RSO and RSC Chairperson must sign all AU Radioactive Material Permit and amendments. In their absence, the license may be signed by an alternate, provided the alternate meets applicable regulatory requirements and is approved by the Radiation Safety Committee (typically another RSC member).

d. Submitted applications must include copies of all the required documents, such as:

- Official research proposal.
- Standard operational procedures (SOPs) for the intended safety use of the radioactive material, waste disposal management, contamination surveys protocols, radiation detector instruments verification and annual calibration, ect.
- Detailed references to justify the necessity of radioactive materials for the proposed research protocol.
- Certificate of Radiation Protection initial training and an annual refresher course.

3. Sanctions for violations of MSC – UPR Radiation Safety Policy

The Rule: All radioactive material received at the MSC must always be secured or under constant surveillance. Shipments of radioactive materials which have not been delivered must be secured at the receiving site by personnel trained by the Radiation Safety Office until delivery can be made. Delivery personnel are prohibited from delivering a package with radioactive materials unless there is an Authorized person (Authorized User, Alternate Authorized User, or Radiation Worker) at the location who will accept it, sign for its receipt, and secure the radioactive materials. Shipments of radioactive materials must not be left unsecure in corridors. If it is necessary to deliver the package to an office, the authorized person receiving the shipment must immediately secure the package in a laboratory or storage room designated for this purpose. If the delivery person cannot find an authorized person to receive the shipment,

the package must be taken to the Radiation Safety Office where it will be secured until delivery can be completed. Radioactive materials are not to be left unsecured at any time.

It is strongly recommended that all laboratories containing used or not in use radioactive materials must always be attended or secured by locking the laboratory when unoccupied during daytime and at night. The required security may be accomplished by locking the radioactive materials within refrigerators, freezers, cabinets, or lock boxes. Wherever possible, lock boxes are recommended for storage of radioactive materials. Only authorized persons may have access to radioactive materials. Radioactive materials that are stored or used in areas common to both authorized and unauthorized personnel must always be secured from unauthorized personnel. Corridors (hallways, elevator lobbies, and utility chases, etc.) are not secured areas. Therefore, the use and storage of radioactive materials in these areas are prohibited.

All radioactive waste is considered as radioactive materials. Radioactive wastes, including dry waste, liquid waste, medical pathological waste, and mixed waste, must be always secured. Radioactive waste may be placed in lockable containers. Recommendations may be obtained from the Radiation Safety Office.

Unescorted unauthorized personnel may not enter a laboratory if an authorized person is not present. Any person admitted into the laboratory must always be accompanied by an authorized person who works in the area. Persons performing work in the area, such as engineering or maintenance personnel, contractors (i.e., janitorial staff, telephone, or computer support personnel) or commercial service representatives must also always be accompanied by an authorized person. A person unknown to the occupants of an area where radioactive materials are used or stored should not be permitted into the area without proper identification and a legitimate reason for entry. A description of these sanctions follows:

- **Level I Sanction**: This sanction will be for violations that appear to be inadvertent or occasional lapses that are discovered by MSC inspection teams. The Authorized User or Radiation Worker must provide the RSC and RSO with a written explanation for the failure and their corrective actions to prevent future failures.
- **Level II Sanction**: This sanction will be invoked for a serious violation or repeated violations that appear to indicate a lack of regard for NRC and MSC radiation safety regulations. This sanction involves a suspension of the Authorized User's or Radiation Worker's access to radioactive material for a minimum of 60 days. All radioactive materials will be confiscated, and the Authorized User/Radiation Worker will be required to retake the radiation safety training course, as well as reapply for permission to use radioactive materials. The RSC may also recommend that the MSC administration take additional disciplinary actions against the Authorized User and/or Radiation Worker.
- **Level III Sanction**: This sanction will be imposed for flagrant violations or those that intentionally set coworkers at risk of injury from radioactive materials. This sanction results in permanent revocation of the use of radioactive materials. The RSC may also recommend that the MSC Administration exert additional disciplinary actions against the Authorized User and/or Radiation Worker.

Failure to comply with the rules and regulations set forth above and throughout this manual may lead to disciplinary actions and/or the cessation of radioisotope shipments and experiments. The RSO and the RSC together may determine to terminate any radioisotope use and/or research if deemed necessary. Suspension or termination of approval to use radioactive materials may result from situations jeopardizing the health, safety and or environment of the MSC community.

4. Ordering radioisotopes and other radioactive materials

The approval for radioactive material quote including both licensed and license-exempt quantities is handled through the Radiation Safety Office. AU are encouraged to establish standing and/or blanket orders for the purchase of radioactive material with the Radiation Safety Office. To establish these orders, each AU must complete the appropriate purchase request and submit a quote to the Radiation Safety Office for approval. Instructions on how to complete the purchase request may be obtained from the Radiation Safety Office. All orders for radioactive materials to be purchased through the MSC shall not be processed until the quote is verified and approved by the Radiation Safety Office.

Once the requested quote has been approved, the AU should place their radioactive material orders with the Purchase Department. Only AUs with an approved and unsuspended application will be allowed to establish standing and/or blanket orders and place radioactive material orders. All requested quotes should include the following information:

Institutions name, Principal Investigator's name, nuclide, maximum activity, vendor, and chemical form. Additional information is requested to present the total amount of nuclides in possession (activity in units of uCi or mCi) and total amount of each type of radioactive waste stored in the laboratory (vials, solids, or liquids). If quotes do not have all the information listed, it will cause a delay upon approval of the radioactive material.

Note that orders for radioactive material must be limited to the isotopes, chemical forms, and maximum activity per shipment as shown on the application form. Orders for other materials or activities greater than specified on the application cannot be ordered. The AUs are required to submit an amendment application to the Radiation Safety Office for the approval of the RSC.

The Radiation Safety Office will review the quote request to determine the following:

a. That the user has been authorized to use the type and quantity of radioactive material being ordered. The name of the AU must be clearly indicated in the order.

b. That the radioactive material being ordered will not cause the AUs inventory limits to be exceeded.

c. That the AU has no unresolved items of safety noncompliance, including responses to survey reports and training notices.

d. That the AU's radionuclide inventory reports are current and updated.

When the above criteria are met, the quote will be approved and signed by authorized personnel of the Radiation Safety Office and the Purchase Department will continue with the purchase order process. The AU or designee will hand to the Radiation Safety Office a package receipt when radioactive material is received in the laboratory. The amount received must be included as an inventory record. If the above criteria are not met, the AU will be notified by telephone to expedite acquisition of the necessary information. Authorization is based on prior protocol approval by the RSC as described earlier.

Every shipment of radioactive material received must be tracked in the inventory database and added with the campus totals. This is to prevent an individual AU, or the campus, from exceeding individual approval or MSC license possession limits respectively.

Note: The purchase of radioactive material by credit cards is not approved by the Central Administration of the University of Puerto Rico and the Medical Sciences Campus will comply with these criteria.

5. Radioactive material permit status

An AU may request that his/her authorization to use and store radioactive materials be temporarily changed to an Inactive Status. This status allows the AU to perform and document survey/wipe tests and inventories on a less frequent basis (quarterly). This provision is designed for laboratories which are not planning on using radioactive materials for at least six (6) or twelve (12) months. The AU may not use radioactive materials with this status (this is a storage only authorization). The AU must submit a request to the RSC to return to active status when so desired.

The "status" of each Authorization (and AU) falls into one of the following categories:

a. **Active:** An AU is authorized by the RSC to use, purchase, and possess radioactive material including equipment containing sealed sources, irradiators, or radiation producing machines. This person purchases or performs experiments with radioactive material or radiation sources at least once a year. A person must remain classified as "active" if they possess any amount of usable encapsulated radioactive material or if they are using equipment containing sealed sources, irradiators, or radiation producing machines.

b. **Inactive:** The AU is authorized to use, purchase, and possess radioactive material including equipment containing sealed sources, irradiators, or radiation producing machines. An inactive user has chosen not to perform experiments utilizing radioisotope or use radiation equipment for a period not exceeding twelve months (one year). A user who wishes to change to inactive status must notify the RSO and the RSC in writing of this decision. An inactive user shall have no usable encapsulated radioactive material (including radioactive waste) in their possession. Inactive users who have equipment containing sealed sources, irradiators, or radiation producing machines must not use them and must declare this information to the RSO and the RSC, in writing, at the same time as they request "inactive" status. If an inactive user desires to reinstate their "active" status, they must notify the RSO and the RSC in writing and fulfill "Active" status training requirements.

c. **Terminating Employment:** If an AU terminates employment at the MSC-UPR, the RSO and the RSC shall be notified within three months in advance. Arrangements must be made to remove or reassign any radioactive materials. Before the termination date, the Radiation Safety Office will conduct a final radiation survey of the laboratory to determine the presence of unused radioisotopes and/or the presence of contamination. This person has no radioactive material, equipment containing radioactive material, or radiation producing equipment. A "terminated status", AU shall have completed (either prior to termination or in absentia) a "close-out" procedure, in which the inventory of radioactive material under the authorization has been disposed or transferred, radioactive waste has been removed, rooms and facilities have been surveyed and determined to be free of radioactive contamination. Documentation of the "close-out" will be maintained by the Radiation Safety Office.

   Radiation workers who terminate their education and/or employment at the university shall notify the Radiation Safety Office and the RSC, and their badges must be returned. Federal law, implemented on January 1, 1994, mandates that new workers who will use radioactive materials must supply the current year's exposure report to the RSO prior to beginning work with radioactive materials. To meet this requirement at future locations, this information will be supplied to a worker leaving the MSC-UPR after the radiation detection badge has been returned to the Radiation Safety Office.

d. Termination of Laboratory Operations (Close – Out): When an AU ends his/her affiliation with MSC-UPR, or desires to terminate his/her radiation permit, any laboratory space controlled by that user must be decommissioned (cleaned out by the AU and checked by the Radiation Safety Office) before the area can be returned to non-radiation use or occupied by another AU. Any AU who anticipates termination his or her Authorization shall notify the RSO and the RSC of the termination in writing or via electronic mail no less than three (3) months prior to the anticipated date of termination.

e. Decommissioning

Permittee Responsibilities:

1. Notify Radiation Safety Office when the Radioactive Materials Permit is no longer needed.
2. Transfer remaining stock materials to radioactive storage area approved by the RSO.
3. Dispose of all unwanted radioactive waste through the Radiation Safety Office.
4. Clean all areas where radioactive materials or waste were used and stored.
5. Perform swipe tests of radioactive use areas**.**
6. Notify Radiation Safety Office and schedule a decommissioning survey be performed by Environmental Health and Safety Office.
7. Transfer the following records to Radiation Safety Office:
    - All actions followed to reduce the contamination of a worker, including name of person surveyed, description of incident with prior work activity, probable cause and steps taken to reduce future incidence of contamination, times, dates, and the surveyor's name and signature
    - Records of spills or other unusual occurrences involving the spread of contamination in and around the facility, equipment, or site
    - Records should include any known information or identification of involved nuclides, quantities, forms, and concentrations
    - Limit records to instances when contamination remains after cleanup procedures or when there is reasonable likelihood that contaminants may have spread to inaccessible areas as in porous materials such as concrete
8. Remove all radiation symbols and sign upon decommissioning release of area by RSO and RSC.
9. Ensure that decommissioning procedure is followed by the Permittee (Faculty or permitted employee under Department's supervision).
10. The RSC will approve the decommission process of the research and clinical laboratories and will release these areas for unrestricted use as required.
11. The Code of Federal Regulations (CFR) Title 10: Nuclear Regulatory Commission, Part 70 Section 38 (10 CFR 70.38) and Part 30 Section 36 (10 CFR 30.36) on the subject of “Expiration and termination of licenses and decommissioning of sites and separate buildings or outdoor areas” states that a process of decommissioning will begin in sites where no principal activities have been conducted for a period of 24 months.

12. NRC will be notified and amendment to the MSC-UPR will be requested if necessary. Documents regarding the decommission process will be available for NRC inspections.

13. If the AU have been in an inactive status for more than two years, he/she will be required to retake the "Radiation Protection Training". The former AU must reapply for authorization and must update all required training and experience information on the AU application, and then must be re-authorized by approval of the RSC.

C. Authorized Users (AU)

All work involving radioactive material must be conducted under the auspices of an approved AU and is ultimately responsible for the safety of those who use radioisotopes under his/her supervision. To become an AU, must complete an application and submit it to the RSC for evaluation. These forms can be found on the MSC website for Institutional Compliance Committees (https://committees.rcm.upr.edu/rsc/).

Applicants must have adequate training and experience with the types and quantities of licensed material that they propose to use. The training and experience are reviewed by the RSC and the application is evaluated for approval or non-approval for the use of radioactive materials. The information demonstrating that each applicant is qualified as an AU by training and experience to use licensed materials will be available in the AU's file. They are required to submit evidence of prior Radiation Protection Training during the application process for medical or research use of radioactive material and radiation sources. This prior education and training may be applied in lieu of certain initial and update training requirements.

The RSC must approve the appointment of all AU's. Each AU must be familiar with 10 CFR 19, 10 CFR 20, safe radiological procedures, and all related requirements of MSC - UPR. AUs should designate an Alternate AU and list their experience and training on the AU Form, which should be submitted to the RSO and the RSC. The Alternate serves in the absence of the AU and can assume any duties as assigned. No delegation of work does not shift responsibility from the AU. He or she must provide adequate supervision to ensure the safety of all personnel using radioisotopes and of any persons who work in the vicinity of radioactive materials. AUs are expected to fully support the ALARA program.

The AU must:

1. Before an experiment is performed, the AU should determine the types and amount of radioactive material to be used. This will generally give a good indication of the protection required. The procedure must be well outlined, and all protocols must be in writing. In many cases, before the procedure is performed with radiation, it should be rehearsed to preclude problem areas or unexpected circumstances. In any situation where there is an appreciable radiation hazard, the Radiation Safety Office shall be consulted before proceeding.
2. Instruct supervised employees on safe radiation practices for all personnel working with radioisotopes. Ensure that all laboratory personnel, including guest investigators, complete the MSC-UPR Radiation Safety Training before they start working in the laboratory as Radiation Workers. People who occasionally enter facilities where radioactive material is handled must be informed of the radioactive hazards. Ensuring attendance at required radiation safety courses. Technologist and resident students should attend the Basic Seminars sponsored by the RSC and organized by the RSO every year. Ensure all individuals working in or visiting his facilities follow the Laboratory Safety Rules.

3. Ensure that all laboratory personnel comply with MSC–UPR radiation safety regulations, policies, and procedures governing the use of radioactive materials as outlined in this manual and required by the NRC.
4. Contact the Radiation Safety Office whenever major changes in operational procedures, alterations in use locations (e.g., the removal of radiochemical fume hood), or when new operations, which might lead to personnel exposure, are anticipated. Provide information concerning individuals and activities in their areas, changes in their personnel and authorized room locations.
5. Complying with the regulations governing the use of radioactive materials, as established by the RSC. This includes:

    - The permit for the use of license material must be justified by the use and approved by the RSC.
    - The quote for purchase of radioactive material will be evaluated and approved by the RSO or personnel of the Radiation safety Office. Keep complete and accurate records of all radioisotopes received, used, and disposed of. This information should always be available during inspection.
    - Submit the vendor's name from which radioactive material will be purchased. New suppliers may request a copy of the MSC-UPR material license.
    - Keeping stocks of stored radioactive materials to a minimum authorized within laboratory areas. Maintaining radionuclide inventory under proper security to prevent unauthorized use.
    - Posting areas where radionuclides are kept or used, or where radiation areas may exist. Properly label all radioactive materials with "Caution: Radioactive Material" label.
    - Assure that areas beyond his facilities are not affected by radiation or radioactive contamination.
    - Providing personal protective equipment and assuring safe procedures are written and discussed with laboratory staff.
    - Assurance of proper labeling of sources, storage areas, contaminated equipment, etc.
    - Performing and recording laboratory surveys consistent with nuclide use and license requirements. To ensure absence of contamination and appropriateness of shielding and maintaining records for inspection reviews.
    - List instruments available for detecting radiation leak and/or contamination, instruments for analysis such as liquid scintillation counters or gamma counters.
    - Check the Geiger Mueller (GM) daily before working with radioactive materials. Maintain GM calibrated on annual basis and operational.
    - Recording the receipt, transfer, and proper disposal of radioactive waste. Also ensuring that radioactive waste requirements are followed.
    - Prevent the transfer of radioactive materials to unauthorized individuals. This includes the proper disposition of radioactive materials possessed by terminating workers and securing radioactive materials against unauthorized removal.
    - Ensuring that all radiation sources are secured when no one is in attendance and keeping laboratory doors always closed.
    - Notification to the RSO of the intended transfer of radioisotopes to another AU.
    - Arranging for transferring of obligations or institutional license termination during extended absences, e.g., sabbaticals or leave without payment.
    - Ensuring that all individuals working in or visiting their radioisotope facilities follow the Radioisotope Laboratory Safety Rules.

6. Ensure that the laboratory has a security plan in case of an accident involving radioactive material. This security plan is submitted with the application for the use of radioactive material. The security plan should follow the security recommendations outlined in this manual.
7. Call the contact emergency number extension number 1000 immediately in case of any fire, explosion, or major accident and tell the dispatcher that the accident involves radioactive materials. Then: notify the Radiation Safety Office immediately of any spill of radioactive materials and of any known or suspected overexposure of personnel to the extension numbers 1687 or 1688. Follow the procedures for a spill.
8. Signs and posted notices required by NRC should be displayed in the laboratory in a visible location.
9. Each AU should maintain an up-to-date binder with all the necessary documentation required by NRC. This binder should contain:
    - Approved purchase of license material by the RSO.
    - Receipt of Radioactive Material and Disposal of Packing Material Form completed (should include a copy of the wipe test results)
    - An updated Isotope Inventory in Refrigerator (Freezer) or Safety Cabinet
    - Reasonably accurate inventory records of radioisotopes at any given time.
    - Radioisotope Management Inventory and Waste Log Sheet
    - Laboratory Daily and Weekly Survey (should include a copy of the wipe test results)
    - Personnel Daily Contamination Survey Form
    - An updated Radiation and Permitted Workers list who use radioactive materials and copies of their training certificates.
    - A copy of the broad scope license of MSC-UPR and the application approved by the RSC.
    - If radiation workers use film badges or rings, a copy of their exposure record will be available at the Radiation Safety Office.
10. Verify that radiation workers make proper use of personnel monitoring equipment such as rings and whole-body badges and confirm that this equipment is always worn correctly.
11. Maintain exposures ALARA (As Low As Reasonably Achievable) through laboratory procedures, shielding, and the use of gloves and other protective clothing. Practice the principles of external protection, i.e., minimize time, increase distance and use shielding when working with radioactive material.
12. Assist the RSO, RSC or NRC in any surveys that are conducted as part of the MSC-UPR Radiation Safety Program.
13. Ensure that the laboratory is surveyed after each experiment and by personnel of the Radiation Safety Office at least once per month. Follow specific instructions for surveys.
14. Ensure that all situations related to radiation safety are identified and corrected in a timely manner.
15. Ensure that before any damaged equipment leaves the laboratory it is surveyed for radioactive contamination and decontaminated if necessary.
16. Renew each year the authorization to continue using radioisotopes. This renewal shall include a review of all application protocols, procedures, and personnel assignments. If an AU does not plan to use radioisotopes, he (she) requests any termination. If an AU does not

plan to use radioisotopes, they must submit a letter to terminate their permit and request a decommissioning process as required.

17. The AU is responsible for the clearance of all radioactive materials, personnel and laboratory equipment and benches as well as completing all related documentation prior to vacating or renovating the laboratory facilities.
18. Complying with the procedure for termination of employment, termination of any experiment using radioactive materials or sites where no principal activities have been conducted for a period of 24 months. The AU is reminded to proceed with the arrangements for the decommission process. A final termination survey must be performed to all specialized equipment and areas where radioactive material was used and stored. The survey results will be analyzed, and the RSC will approve and release these areas for other uses. The radioactive materials (including waste) assigned under his/her permit will be removed from the laboratory, personnel monitoring devices (badges and rings) and shielding materials are returned to the Radiation Safety Office.

Authorized User (AU) Absences:

A permit is granted on the grounds that the holder is aware of and responsible for the activities in the radioisotope facilities. If a permit holder is taking a sabbatical or other type of leave where he or she will not be able to administer this responsibility, arrangements must be made prior to taking the leave. An AU may be occasionally absent from the laboratory for various reasons. During such absences, another individual must be named to assume the responsibility for the correct usage and management of radioactive materials. When the absence is less than 60 days, a responsible graduate student or laboratory technician may be appointed to assume responsibility. If the absence is greater than 60 days, an alternate AU with the appropriate radioisotope approvals must be designated and must agree to assume responsibility.

Before departure, the RSC and the RSO must be notified in advance and in written of the intended absence, duration and the name of the alternate AU who will oversee the use of radioactive material. The stand-in AU must have all the authorizations necessary to oversee the uses of the radioactive materials possessed by the absent AU. During the absence, shipments will still be logged under the absent AU's inventory, but all oversight will be conducted by the stand-in AU. Any permit holder acting on behalf of another permit holder is responsible for all activities under both permits and will be subject to any necessary disciplinary action.

A facility may be declared to be abandoned when the permit holder is no longer employed by the MSC-UPR, takes a sabbatical/ leave and is not physical present at the installations of the MSC-UPR for more than 3 months and has not notified the RSO of any alternative arrangements. The following actions will take place:

- The *RSO* will immediately arrange for the decommissioning of the facilities and the disposal of all radioactive material in those facilities. If significant costs are involved in this procedure, all costs will be charged to the department with the abandoned facility.

Failure to comply with the rules and regulations set forth above and throughout this manual may lead to disciplinary actions and/or the cessation of radioisotope shipments and experiments. The RSO and the RSC together may determine to terminate any radioisotope use and/or research if deemed necessary. Suspension or termination of approval to use radioactive m01aterials may result from situations jeopardizing the health, safety and or environment of the MSC community.

D. RADIATION WORKERS

The responsibilities of the Radiation Worker:

Individuals who use radioactive materials assume certain responsibilities in their work. Since the workers themselves are the direct handlers of the radioactive material, the ultimate responsibility lies with them for safety and compliance with laws and regulations. For this reason, it is critical that they be aware of the risks, safe practices and requirements for use, management, and disposal of radioactive materials.

The term "worker" is used by the university to identify an individual who uses radioactive material in the course of his/her employment or academic studies. The Workers may be graduate students, technicians, post-doctoral fellows, and any other individual working under the supervision of an AU, who handles radioactive material. The following items are to be always adhered to by radiation workers:

1. Each worker must complete an appropriate Radiation Safety Training Course prior starting with their duties in the laboratory.
2. Workers are responsible for adhering to all laws, rules, regulations, license conditions and guidelines pertaining to the use of radioactive materials as outlined in this Manual and required by the NRC. Knowledgeable of the MSC Radiation Safety Manual and be responsible for its contents as applicable to their duties in the laboratory.
3. Workers must wear their assigned radiation dosimeter when using radioactive materials, if applicable. Personnel who work only with pure alpha emitters or only with pure beta emitters having a maximum energy of less than 0.25 MeV will not be required to wear badges. This includes H^3, C^{14} and S^{35}. Workers are responsible to report the RSO of any loss or contamination of the dosimeter. Maintain exposures ALARA through safe laboratory procedures and below the maximum permissible doses as listed in the following table:

Annual Occupational Dose Limits for Adults	
Whole body – Total Effective Dose Equivalent (TEDE)	5,000 mrem
Lens of the eye (LDE)	15,000 mrem
Extremities – Shallow Dose Equivalent (SDE)	50,000 mrem
Skin – Shallow Dose Equivalent (SDE)	50,000 mrem
Total Organ Dose Equivalent (TODE)	50,000 mrem

4. Workers must practice ALARA (As Low As Reasonably Achievable) in their work, and minimize the potential for exposures, contamination or release of radioactive materials, applying the principles of time, distance and shielding to reduce exposures.
5. Performing surveys on their hands, shoes, and body for contamination, and removing all loose contamination at the end of the day and before leaving the laboratory. Minimize the potential for exposures, contamination, or release of radioactive materials. If contamination is found, it must be cleaned up. Complete a contamination Report and notify the Radiation Safety Office for guidance and recommendations. Notify RSO/Radiation Safety Office immediately of any spill of radioactive materials and any known or suspected radiation exposure. The AU and RSO will supervise/assist. Follow the procedures for a spill.
6. Keeping the laboratory organized and clean. DO NOT LEAVE IT FOR ANOTHER PERSON TO CLEAN UP. The work area should be free from equipment and materials not required for the immediate procedure to ensure a safety work environment. Wherever practical, keep work surfaces covered with absorbent material, preferably in a stainless-steel tray or pan, to limit and collect spillage in case of an accident.

7. No changes in experimental procedures using radioactive materials are to occur without the approval of the AU. Do not take short cuts. Changes in experimental procedures impacting upon safety (higher quantities, higher risk, use in animals, etc.) must be approved by the RSC.
8. Utilizing appropriate protective measures for laboratory safety practices such as:
    - Wearing protective clothing whenever contamination is possible. Do not wear such clothing outside of the laboratory area if contaminated.
    - Wear disposable gloves or double gloves and lab coats when necessary.
    - Do not work with radioactive materials if there is a break in the skin below the wrist without first covering it.
    - Using protective barriers and other shields whenever practical.
    - Using pipette filling devices. Never pipette radioactive solutions by mouth
    - Wash hands thoroughly after handling radioactive materials.
9. The use of food, drinks, candy, handling of contact lenses, tobacco, and application of cosmetics, lotion, or lip balm is prohibited in areas where radioactive material is used or stored. Refrigerators shall not be used jointly for foods and radioactive materials.
10. All radioactive areas and containers with radioactive material should be identified with a label with “Caution, Radioactive Material”:
    - Radioactive waste containers
    - Radioactive storage areas such as refrigerators, safety cabinets, etc.
    - Waste or Decay storage area
    - Radioactive material containers such as: radioactive vials, reference sealed sources containers, patient dose containers, flood source for calibration purpose
    - Specialized and dedicated instruments or equipment for the use of radioactive material such as: centrifuge, liquid scintillation counters, gamma counters, geiger mueller counters (GM), etc.
11. Requesting Radiation Safety Office supervision of any emergency repair of contaminated equipment in the laboratory by shop personnel or by commercial service contractors. At no time shall service personnel be permitted to work on equipment in radiation areas without the presence of a member of the laboratory staff to provide specific information.
12. Reporting accidental inhalation, ingestion, or injury involving radioactive materials to the supervisor and the Radiation Safety Office and carrying out their recommended corrective measures immediately. The individual shall cooperate in all attempts to evaluate his exposure. The supervisor shall complete and submit an accident report to the Radiation Safety Office within the next 24 hours.
13. Workers are responsible for informing the RSO of any exposures which have occurred at a previous employer when beginning employment at MSC. They are also responsible for notifying the RSO of termination of employment and returning the radiation dosimeter at the end of their employment.
14. Workers are responsible for maintaining the security of radioactive materials. Follow the recommendations of the AU for those procedures that are specific to their laboratory for the storage, usage, recording, and disposal of radioactive materials.
15. Call the Security Office of the MSC immediately for any fire, explosion, or major accident and tell the dispatcher that the accident involves radioactive materials. Next, notify the Radiation Safety Office and their immediate supervisor and/or the Authorized User

responsible for their laboratory. Emergency numbers must be posted near the telephone and visible to the laboratory personnel.

E. PERMITTED WORKERS

A permitted worker is a laboratory worker who does not work with radioactive materials but works in a radiation laboratory. To be a permitted worker, the employee must successfully complete the "Radiation Safety Training Course" or equivalent (radiation hazard instructions).

The duties of Permitted Workers are as follows:

1. Enroll, attend, and complete the one-hour Radiation Safety Training Course.
2. Wear issued radiation monitoring badges in the radiation laboratory when necessary.
3. Use the principles of time, distance, and shielding to protect themselves from radiation exposure.
4. Confer with radiation workers to find out where radioisotopes are used and stored so that these areas can be avoided.
5. Report any observed radiation safety infractions, shortcomings, or failures to the RSO in a timely manner.

F. Radiation Safety Training:

All AUs, and radiation workers, must receive instruction on radiation safety, biological effects of radiation, regulatory requirements, and laboratory techniques. The MSC Radiation Safety Program is designed to achieve strict compliance with applicable Federal regulations. *Title 10, Code of Federal Regulations, Part 19, Section 12 "Instructions to Workers" (10 CFR 19.12)* is the regulation requiring training of all individuals working in or frequenting any portion of a restricted area associated with radioactive materials or radiation. To meet the regulatory requirements on the training of radiation workers, the Radiation Safety Office operates an extensive training program. The type of radiation safety training required depends on the nature of their involvement with sources of radiation. Each employee is required to have annual refresher training.

The goal of providing radiation safety training to the employees of the MSC-UPR is to empower workers to take personal responsibility for minimizing their exposure to radiation. By providing each employee with knowledge of radiation and its biological effects and the regulations governing its use, the MSC–UPR can help provide an environment that is safe for its patients, students, visitors, and workers. The content of radiation safety training courses will be determined by the Radiation Safety Officer and the appropriate Radiation Safety Committee based on applicable regulatory guidance, industry consensus standards, and the specific needs of the target audience.

The AU (principal investigator) is responsible for offering radioactive protection training to their staff and ensuring that all radioactive material users within his/her laboratory are trained on the safe use of radioactive material prior to beginning work. This training must include information on the safe use, handling, storage, and disposal of radioactive material as well an explanation of the risks associated with exposure to ionizing radiation, the precautions, or procedures for minimizing radiation exposure, the purpose and function of protective devices employed and radiation protection. The AU is responsible for maintaining documentation of the completion of

required training and will be required to supply such documentation to the RSO or his/her designee as a condition for continued authorization to use radioactive material or radiation sources. If the AU is unable to provide the training, a senior laboratory technician may provide the necessary training. However, this training does not relieve the AU from the responsibility of the individuals working in his/her laboratory.

New AUs are required to take the radiation safety course offered by the Radiation Safety Office and a refresher course annually. This annual refresher course can be accomplished by viewing the radiation safety video available at the following MSC web page: http://web.rcm.upr.edu/vidsrcm/radiationsafety.htm. Users may take an online Radiation Safety Course every other year as long as they provide evidence of the training.

Individuals or Groups Requiring Training and Frequency Done:

Individuals employed by the MSC-UPR fall into four general categories with respect to their exposure to radiation. Training occurs on an as-needed basis. However, the Radiation Safety Office subscribes to some basic guidelines for the frequency and intensity with which different groups receive their training. These include:

a. Before assuming duties with, or in the vicinity of, radioactive materials (for users and awareness-level employees).

b. Whenever there is a significant change in duties, regulations, or the terms of the license (for users and awareness-level employees).

c. Radiation workers: initial training including instruction in the proper use, handling and disposal of radioactive material and other sources of ionizing radiation. The content of the initial training may be modified for the specific job responsibilities.

d. Radiation workers and certain ancillary workers: periodic refresher training.

e. Re-training of workers whose job responsibilities change concerning their use of or exposure to ionizing radiation, or who request additional radiation safety training.

f. Special training in connection with incidents involving a spill, accident, changes in regulations, or a documented overexposure.

The four general categories are:

1. **Authorized User (Principal Investigator and Nuclear Medicine Physicians):**
   - Must present evidence of prior training and experience of working with radioactive material.
   - Are required to take a ten (10) hour training course from the Radiation Safety Office of the MSC-UPR. This training must be completed before the approval of the Radioactive Material Use Permit.
   - After 10-hour training course a one-hour refresher course will be required annually. The PI will receive radioactive information concerning any changes to the ALARA Program of the MSC-UPR annually.

2. **Radiation Worker:** those workers whose major responsibilities involve working with sources of ionizing radiation or radioactive material. They would include, Radiation Safety Office personnel, Nuclear Medicine Technologists, Nurses, Lab Technicians, Graduate

Students, Post-Doctoral Fellows, and any other individual working under the supervision of an AU:

- For these individuals, the Radiation Safety Office offers similar training, but there is no final examination or certificate for this training and students who take this course may not work with radioactive materials without direct supervision by someone who has completed the regular Ionizing Radiation Protection Course.
- The AU must ensure that individuals working under their control are properly supervised and trained to enable safe working habits and prevent exposures to themselves and others and/or contamination of the work areas or environment.
- They are required to take a five (5) hour training course from the Radiation Safety Office of the MSC-UPR. This training must be completed before starting to work with an AU.
- After the five-hour training course a one-hour annual refresher course will be required.

3. **Permitted Worker:** a person who works in a laboratory with a researcher who is an AU but does not handle any radioactive materials (undergraduate students). To be a permitted worker, the employee must successfully complete a "General Radiation Safety Training Course" or equivalent. This can be accomplished by viewing the Radiation Safety video, receiving radiation hazards instructions and appropriate precautions by the AU. The AU must certify in written that they received the instructions and present a copy of the certificate to the Radiation Safety Office**.** For these individuals, the Radiation Safety Office offers similar training, but there is no final examination or certificate for this training and students who take this course may not work with radioactive materials without direct supervision by someone who has completed the regular Ionizing Radiation Protection Course. They can be informed by the AU or designee (Lab Technician or Nuclear Medicine Technologist) about radiation hazards and the appropriate precautions. The video is available at the MSC web page: http://web.rcm.upr.edu/vidsrcm/radiationsafety.htm

4. **Ancillary Workers:** In addition, ancillary staff is required to receive radiation safety instructions of radiation hazards or training, includes personnel engaged in janitorial and/or housekeeping, engineering service personnel, shipping and receiving workers, receptionist, and security. The training program for ancillary personnel performing duties that are likely to result in a dose more than 1 millisievert (100 millirem) will include instruction commensurate with potential radiological hazards in the workplace. Alternatively, prohibitions on entry into controlled or restricted areas may be applied to ancillary personnel unless escorted by trained personnel. From time to time, as regulations change and new requirements are introduced, it will be necessary to conduct specialized and/or refresher training.

- Maintain informed of the storage, transfer, or use of radiation and/or radioactive material
- Instruct of potential radiological hazards and biological effects associated with exposure to radiation and/or radioactive material, precautions, or procedures to minimize exposure, and the purposes and functions of protective devices (e.g., ALARA concepts of time, distance, and shielding)
- The applicable provisions of NRC regulations and licenses for the protection of personnel from exposure to radiation and/or radioactive material (e.g., posting and labeling of radioactive material)
- Their responsibility to report promptly to the licensee any condition that may lead to or cause a violation of NRC regulations and licenses or unnecessary exposure to radiation and/or radioactive material (e.g., notification of the RSO regarding safety issues)

- Appropriate response to warnings made in the event of any unusual occurrence or malfunction that may involve exposure to radiation and/or radioactive material
- Advise as to the radiation exposure reports that workers must be furnished pursuant to regulations.
- After this a one-hour annual refresher course will be required.

Non-Radiation Workers: personnel who would not normally be expected to encounter radioactive material or radiation sources in the course of their employment at the MSC-UPR. These include administrators and administrative assistants, food service employees, clerical staff, and so forth.

SECTION III GROUPS IN THE TRAINING PROGRAM AND FREQUENCY

Group	Frequency
1. Authorized Users: Nuclear Medicine Physicians and Principal Investigators	• 10 hours before assuming duties • 1-hour annual refresher course
2. Radiation Workers: Radiation Safety Office personnel, Nuclear Medicine Technologists, Nurses, Lab Technicians, Graduate Students, Post-Doctoral Fellows, and any other individual working under the supervision of an AU.	• 5 hours before assuming duties • 1-hour annual refresher course
3. Permitted Worker: Undergraduate students (usually short period of time): For laboratory workers (e.g., students), who are NOT radiation workers but work for a researcher who is an AU. It is his/her responsibility to provide appropriate training. The training should be commensurate to their potential exposure to radiation. In some cases, training may not be necessary (e.g., workers not required to work in any of the laboratories where radioactive material is authorized). The AU may also contact Radiation Safety Office for assistance and the students may participate in the RSO Annual Refresher Training.	• 1-hour before assuming duties • 1-hour annual refresher course
4. Ancillary Personnel: Housekeeping, janitors, security, and clerical personnel	• 1 hour before assuming duties • 1-hour annual refresher course
5. Newly appointed researchers without previous acceptable training	• 10 hours before assuming duties • 1-hour annual refresher seminar
6. Newly appointed research technicians without previous acceptable training	• 5 hours before assuming duties • 1-hour annual refresher seminar
7. Radiation Safety Committee	• 2 hours seminar about ALARA program

- ***"AS LOW AS REASONABLY ACHIEVABLE" (ALARA) PHILOSOPHY***

ALARA is an acronym meaning **A**s **L**ow **A**s **R**easonably **A**chievable. It is a requirement in the law, meaning all facilities possessing radioactive materials licenses must have a formal ALARA program. It may be defined as a professional standard of excellence, and is practiced by keeping all doses, releases, contamination, and other risks as low as reasonably achievable. The regulatory guideline requires managing programs and procedures to achieve 10% of applicable legal limits, such as air and water release limits, exposure limits or contamination limits for radiation use facilities.

It is not a violation of the law to exceed an ALARA guideline; however, these occurrences alert the radiation safety officer and radioactive materials users to situations which need to be reviewed to determine whether the practices may be modified to better reflect ALARA management practices. Practical measures to incorporate ALARA into work routine are included in this manual to assist radiation workers. Some simple concepts and easy precautions may prevent contamination, exposures, and releases.

Our ALARA program depends on the cooperation of all users of radionuclides at the MSC. The program includes the use of proper equipment and procedures to lower radiation exposure. The RSO will investigate any whole-body dose more than 125 millirems (mrem) or 1,875 mrem to the extremities to any individual in any one quarter. If any worker receives a whole-body dose more than 375 mrem or 5,625 mrem to the extremities per quarter, direct actions will be taken to minimize any future exposures. These actions may require a change in laboratory procedure or an increased application of the principles of personnel protection.

G. INVESTIGATIONAL LEVELS IN ORDER TO MONITOR INDIVIDUAL OCCUPATIONAL EXTERNAL RADIATION EXPOSURES:

This institution hereby establishes Investigational Levels for occupational external radiation exposure. If these levels are exceeded, an investigation by the Radiation Safety Committee and/or the RSO will ensue.

These levels apply to the exposure of individual workers.

Table 1. Investigational Levels (mrems)

	For a given quarter		Cumulative for the year	
ORGANS	LEVEL I mRem	LEVEL II mRem	LEVEL I mRem	LEVEL II mRem
Whole body deep (total effective dose equivalent)	125	375	500	1,500
Individual organs - except lens (sum of deep dose equivalent and committed dose equivalent)Whole body shallow	1,250	3,750	5,000	15,000
Lens eyes	375	1,125	1,500	4,500

Skin or extremity	1,250	3,750	5,000	15,000
Hands and forarms; feet and ankles	1,875	5,625	7,500	22,500
Skin of whole body	750	2,250	3,000	9,000
Organs	1,250	3,750	5,000	15,000

*Note: Investigational levels I and II are one tenth and three tenths, respectively, of the applicable regulatory limits.

The Radiation Safety Officer will review and record on NRC-5 form, "Occupational Exposure Record for a Monitoring Period," or on an equivalent form (e.g., dosimeter processor's report), results of personnel monitoring at least once in any calendar quarter as required by section 20.2102 of 10 CFR Part 20. If personnel are found that have exceeded this limit, the following actions will be taken:

1. Personal dose to less than Investigational Level I:

    a) No action will be taken in cases where an individual's exposure is less than Table 1 values for the Investigational Level I.

2. Personal dose equal to or greater than Investigational Level I, but less than Investigational Level II:

    a) The RSO will review the exposure of everyone whose quarterly exposures equal or exceeds Investigational Level I and will report the results of the reviews at the first Radiation Safety Committee meeting following the quarter when the exposure was recorded. If the exposure does not equal or exceed Investigational Level II, no action related specifically to the exposure is required unless deemed appropriate by the Committee. The Committee will, however, consider each such exposure in comparison with those of others performing similar tasks as an index of ALARA program quality and will record the review in the Committee minutes.

3. Personal dose equal to or greater than Investigational Level II:

    a) The RSO will investigate in a timely manner the cause(s) of all personnel exposure equaling or exceeding Investigational Level II and, if warranted, will take action. A report of the investigation, actions taken, if any, and a copy of the individual's Form NRC-5 or its equivalent will be presented to the Radiation Safety Committee at the first Radiation Safety Committee meeting following completion of the investigation. The details of these reports will be recorded in the Radiation Safety Committee minutes. Committee minutes will be sent to the management of this institution for review. The minutes, containing details of the investigation, will be made available to NRC/State inspectors for review at the time of the next inspection.

4. Reestablishment of an individual occupational worker's Investigational Level to a level above that listed in Table 1:

    a) In cases where a worker's or a group of workers' exposure needs to exceed an Investigational Level, a new, higher Investigational Level may be established on the basis that it is consistent with good ALARA practices for that individual or group. Justification for new Investigational Levels will be documented. The Radiation Safety Committee will review the justification, and must approve or disapprove, all revisions of Investigational Levels.

External Radiation Exposure and Protection

The body may be irradiated in two general ways: externally from radioactive material or radiation sources, or internally from radioactive material deposited in the body. External doses can be the result of exposure to gamma, X-ray, or high energy beta emitters. Low energy beta and alpha emitters lack the energy needed to penetrate the outer layer of skin and subsequently present less of an external hazard; they are of more concern when ingested. The external dose an individual receives depends on the following factors: exposure, time, distance, and shielding.

Radiation dose rate is the radiation dose delivered per unit of time. The unit of radiation dose rate is usually rem/hour, mrem/hour, or µrem/hour. To eliminate or reduce radiation exposure, one must reduce the dose rate, or the time spent near a source of radiation. Three primary means of eliminating or reducing radiation exposures exist. They include:

1. ***Exposure:*** The "strength" (activity, mR/hr, etc.) of the radiation source. By reducing the amount of radioactive material used (lowering the current settings on a radiation producing machine) dose can be reduced.

2. ***Maximize the distance from the source:*** The dose rate for most gamma and x-radiation varies with the inverse square of the distance from a "point" source. Therefore, the farther you position yourself for the source of radiation, the smaller the dose you receive. Mathematically, $I_2/I_1 = r_1^2/r_2^2$. This is called the inverse square law. For example, if the dose rate is 100 mrem/hour at 5 cm from a point source, you can calculate the dose rate at 20 cm from the source:

   $I_{20cm}/I_{5cm} = (5cm)^2/(20cm)^2$

   $I_{20cm} = (100\ mrem/hr) \times (5cm)^2/(20cm)^2$

   $I_{20cm} = 6.25\ mrem/hr$

   For example, doubling the distance from a radiation source will result in 1/4 the exposure in the same amount of time. One practical implementation of this principle is using remote handling devices such as forceps, tongs, and tube racks, etc. to minimize direct contact with sources and containers. Even a small increase in distance can result in a dramatic decrease in dose rate.

3. ***Minimize time of exposure:*** The less time you remain in a radiation field, the smaller the dose you receive. Perform the experiment or the procedure as quickly and as efficiently as possible without increasing the probability of a spill or other accident.

4. ***Shield the radiation source:*** If the radiation source is a high energy beta or gamma emitter, shielding will reduce the dose rate. For beta emitters, use a low atomic number material such as plastic, Lucite, Plexiglas, and glass. For gamma emitters, high atomic number materials such as steel or lead are preferred (lead is also a toxic material, so use gloves when handling it, and wash your hands when you finish).

   Place shielding between yourself and a source of penetrating radiation to decrease your dose. For low energy beta emitters (^{3}H, ^{14}C, ^{33}P, and ^{35}S) shielding is not necessary. For high energy beta emitters (^{32}P), 3/8" acrylic is the shielding material of choice. Does not use lead with high energy beta radiation (e.g., ^{32}P) because it will cause secondary radiation of a more penetrating X-ray type radiation. For gamma or x-ray emitters (^{51}Cr and ^{125}I) lead is used when exposure rates are significant.

   Use shielding wherever it is necessary to reduce or eliminate exposure. By placing an appropriate shield between the radioactive source and the worker, radiation is

attenuated, and exposure may be eliminated or reduced to an acceptable level. The type and amount of shielding needed to achieve a safe working level varies with the type and quantity of radioactive material used.

Internal Exposure Protection:

Internal exposure results from the absorption, ingestion, or inhalation of radioactive material. This material can be incorporated in the body in several ways: (1) by breathing radioactive gases, vapors or dust; (2) by consuming radioactive material transferred from contaminated hands, tobacco products, food or drink; (3) by entering through a wound; and (4) by absorption through the skin.

The fundamental objectives of radiation protection measures are: (1) to limit entry of radionuclides into the human body (via ingestion, inhalation, absorption, or through open wounds) to quantities as low as reasonably achievable and always within the established limits; and (2) to limit exposure to external radiation to levels that the established dose limits are below and as low as reasonably achievable.

1. ***Inhalation:*** A chemical fume hood certified for radioactive material work is highly recommended when using potentially volatile compounds. Certain equipment, such as centrifuges, vortex mixers, and shakers can generate radioactive aerosols. Use in such a way that production of and exposure to radioactive aerosols is minimized.
2. ***Puncture:*** Dispose of syringes and pipettes promptly and in appropriate containers. Guard against glass breakage and puncture injury during use and disposal. Do not attempt to recap needles before disposal.
3. ***Ingestion:*** NEVER introduce any food or drink into a posted restricted area, even for temporary storage. DO NOT eat or drink in any area where radionuclides are used, never pipette by mouth, and never store food and drinks in a cold room or refrigerator that is designated for radioactive material storage.
4. ***Absorption:*** Use measures that prevent the contamination of skin and eyes. If there is any possibility that the clothes have been contaminated, remove this clothing before leaving the lab. Eye protection, (e.g., goggles, face shield) is encouraged to prevent contamination of the eyes. This is particularly important for individuals wearing contact lenses since some lenses will absorb and concentrate radiochemical. Always wear protective gloves when working with radioactive materials. Change gloves frequently during the work, disposing of the used gloves as radioactive waste. Wash hands after using radioactive materials and monitor the hands for contamination, especially before eating or smoking, and prior to leaving the laboratory.

I. PROCUREMENT

1. Application for the use of Radioactive Materials:

Approval for the use of radioactive materials is given by the RSC and is reviewed periodically. Approval may be obtained by submitting an application describing the requested material and quantity to be used, the location, individuals who will handle the material, present evidence of training and experience of the applicant working with radioactive material, the training of workers, the protective equipment to be used, if any, monitoring equipment, a brief description of experimental procedures and protocols with emphasis on potential safety concerns, methods and a description of measures employed to minimize radiation exposure to the experimenter, any human subjects and the protection of the environment and waste disposal information.

New applications are required for the use of a new radionuclide, for a change in experimental procedures which have an impact on safety, and for a change in chemical or physical form of a material previously approved.

2. Amendments for a Radioactive Permit:

Amendments to current approvals are given for slight increases in quantity or moderate changes in chemical form and may be obtained by applying and stating the desired change and the reason for the change, referencing to the original approved application to be amended. Applications for approval or amendments should be directed to the RSO. Amendments are considered changes in laboratory locations, radioisotopes, radioisotopes limits, and proposed uses, laboratory personnel who work with radioactive material, changes in use and storage areas and other minor changes. An AU must submit a new application if other radionuclides are to be used or if the change in procedures will significantly alter radiological hazards.

The RSC will review the application, evaluating the facilities available, the training and experience of the applicant and staff for the proposed use, and the details of the work to be performed. After the evaluation, the application must be approved by a two-thirds majority vote of the RSC members.

The procedures approved in the application become the conditions under which the researcher and his/her personnel are authorized to use radioactive material. Any subsequent change in procedure regarding the use, storage or disposal of sources must be reviewed and approved by the RSC. Any AU that might use radioactive material in studies involving animals must submit the investigation proposal to the Institutional Animal Care Use Committee (IACUC) for their proper evaluation and authorization.

a. Procedures to be conducted to amend an authorization:

- **Notifications for room changes (adding new lab or discontinuing use in a lab)**

  Radioactive material may only be used in laboratories and cold rooms approved by the RSC. To amend your areas of use, submit an amendment request form listing the change (building and room number) and the effective date of this change to the Radiation Safety Office. If the room change involves the termination of radioactive material work in that lab, the Radiation Safety Office will perform a decommission process certifying that no radiological hazards exist in the space.

  Please note: If your lab is moving to a new location or if you are leaving the University, the Radiation Safety Office requires 3 months advance notification to schedule the surveys, radioactive waste removal, and cancellation of all radiation safety related services. Submit the application by email to the RSO. Lab equipment used in radioactive

material experiments must be surveyed prior to packaging by the moving company. In addition, a close-out survey is conducted after the movers have removed all equipment.

- **Notification of changes in possession limits and physical or chemical form.**

  To add a new radiochemical, apply for an amendment request listing the change to the RSC to be evaluated and submit it to the Radiation Safety Office.

- **Adding laboratory personnel who will work with radioactive material**

  Laboratory personnel who work with radioactive material are required to be listed on the application. To update the laboratory personnel list, a copy of the Radiation Safety Training certificate must be submitted to the Radiation Safety Office with the application form.

- **Adding or modifying survey instruments**

  To add a new survey instrument, add a new probe, or discontinue use of a survey instrument, you are to submit a memo or email outlining the change including the instrument's model and serial number. A member of the Radiation Safety staff will contact the lab designee to conduct the change.

  Please note: If you have purchased a new radiation detector meter (GM), the Radiation Safety Office will affix a sealed source to the instrument to be used for its operational checks. A copy of the calibration certificate must also be submitted to the Radiation Safety Office. If you are unable to locate the calibration certification, the Radiation Safety Office will be required to recalibrate the instrument.

4. ***Ordering Radioisotopes and Other Radioactive Materials:***

The purchase of radioactive material including both licensed and license-exempt quantities is handled through the Radiation Safety Office. Principal investigators are encouraged to establish standing and/or blanket orders for the purchase of radioactive material with the Radiation Safety Office. To establish these orders, each principal investigator must complete the appropriate purchase request and hand carry it to the Radiation Safety Office for approval. Instructions on how to complete the purchase request may be obtained from the Radiation Safety Office. All orders for radioactive materials to be purchased through the MSC shall not be processed until approved by the Radiation Safety Office.

Once your standing and/or blanket order has been established, research groups should place their radioactive material orders with the Radiation Safety Office. Only principal investigators with an approved and unsuspended application will be allowed to establish standing and/or blanket orders and place radioactive material orders. All requests should include the following: Principal Investigator's Name, Nuclide, Maximum Activity, Vendor, and Chemical Form. Additional information is requested to present the total amount of nuclides in possession Activity in uCi or mCi) and total amount of each type of radioactive waste stored in the laboratory (vials, solids, or liquids). If orders do not have all the information listed, it will cause a delay upon approval of the radioactive material.

Note that orders for radioactive material must be limited to the isotopes, chemical forms, and maximum activity per shipment as shown on the application form. Orders for other materials or activities greater than specified on the application cannot be ordered. Researchers are required to submit an amendment application to the Radiation Safety Office for the approval of the RSC.

The Radiation Safety Office will review the order request to determine the following:

1. That the user has been authorized to use the type and quantity of radioactive material being ordered. The name of the Authorized User must be clearly indicated on the order.
2. That the radioactive material being ordered will not cause the Authorized User's inventory limits to be exceeded.
3. That the Authorized User has no unresolved items of safety noncompliance, including responses to survey reports and training notices.
4. That the Authorized User's radionuclide inventory reports are current.

When the above criteria are met, the order will be approved and signed by authorized personnel of the Radiation Safety Office. The Principal Investigator or designee will hand to the Radiation Safety Office a package receipt when radioactive material is received in the laboratory. The amount received must be included as an inventory record. If the above criteria are not met, the Authorized User will be notified by telephone to expedite acquisition of the necessary information. Authorization is based on prior protocol approval by the RSC as described earlier. Every shipment of radioactive material received must be tracked in the inventory database and added with the campus totals. This is to prevent an individual Authorized User, or the campus, from exceeding individual approval or MSC license possession limits respectively.

Note: The purchase of radioactive material by credit cards is not approved by the Central Administration of the University of Puerto Rico and the Medical Sciences Campus will comply with these criteria.

5. Receiving and Monitoring Radioisotope Shipments:

The Radiation Safety Office must approve all orders for radioactive material and ensure that the requested material, quantities, manufacturer, and model are authorized by the license and that the possession limits are not exceeded.

Receipt of radioactive materials shipments should be between 7:00 AM to 4:00 PM Monday to Friday. Shipments are delivered directly to the Authorized User's laboratory. A designated, trained individual will receive it and follow the guidelines for package receipt and opening.

Upon receipt of a shipment, the exterior of the package is checked for contamination (as required by regulations). The package must be surveyed at its surface and at one meter with the GM counter and a wipe test must be performed. The results must be documented in units of mRem/ hr and dpm and kept in the logbook. **Receipt of Radioactive Material and Disposal of Packing Material Form)**

The RSO and the final delivery carrier must be notified immediately by telephone and telegram, mail or fax if contamination on any package exceeds 0.001 uCi (2200 dpm) per 100 square centimeter (for beta and gamma emitting radionuclide) or if the external radiation levels exceed 200 mrem/hr at any point on the external surface (10 CFR 20.1906(d)). The RSO will notify the NRC of this situation by phone or by fax.

The Radiation Safety Office personnel will notify the PI that the radioactive material ordered has arrived and will make the arrangements with the PI for the pickup of this package. A form will be signed by the person who receives the package.

A refrigerator will be available in the Radiation Safety Office for those radioactive materials that need to be stored in specific temperatures upon receipt. It is the PI's responsibility to pick up the package the same day or within the next 24 hours after delivery.

If the package is not contaminated, the RSO or his designee will stamp the package approved and will sign and date it. After being recorded in the radioactive material logbook, packages will be delivered to the Authorized User/laboratory.

If an Authorized User or Radiation Worker opens a package and discovers that the contents have been spilled because the container has been broken or is cracked, he or she must notify the Radiation Safety Office immediately for guidance. The package should be contained to a restricted area to minimize spread of contamination until it can be safely sealed and removed.

For deliveries during off-duty hours, the RSO will tell security personnel or other designated persons to accept delivery of radioactive packages in accordance with procedures outlined in the sample memorandum. **Memorandum Form.**

6. *Procedures for Safety Opening Packages Containing Radioactive Material:*

For packages received under the specific license, the following procedure for opening each package will be followed **Receipt and Survey of Radioactive Material and Disposal of Packing Material):**

1. Put on gloves to prevent hand contamination.
2. Visually inspect the package for any sign of damage (e.g., wet or crushed). If damage is noted, stop the procedure, and notify the Radiation Safety Officer (RSO).
3. Measure the exposure rate from the package at 1 meter and at the package surface. If it is higher than expected, stop, and notify the RSO. (The "transport index" noted on packages with "Yellow II" or "Yellow III" labels is the approximate dose rate, in millirems per hour, at 1 meter from the package surface (10 CFR 71.4); the surface dose rate for Yellow III packages should not exceed 200 millirems per hour. The dose rate from packages with "White I" labels should be less than 0.5 millirems per hour at the package surface (49 CFR 172.403).
4. Open the package with the following precautionary steps:
   a) remove the packing slip.
   b) open the outer package following the supplier's instructions, if provided.
   c) open the inner package and verify that the contents agree with the packing slip.
   d) check the integrity of the final source container. Look for broken seals or vials, loss of liquid, condensation, or discoloration of packing material.
   e) if anything is other than expected, stop and notify the RSO.
5. For all packages wipe the external surface of the final source container and remove the wipe sample to a low-background area. Assay the wipe sample to determine if there is any removable radioactivity. The NaI well counter will be used to assay wipes. The detection efficiency must be determined to convert wipe sample counts per minute to disintegrations per minute. Note that a dose calibrator is not sufficiently sensitive for this measurement. Take precautions against the potential spread of contamination.
6. Check the user request to ensure that the material received is the material that was ordered.
7. Monitor the packing material and the empty packages for contamination with a radiation detection survey meter before discarding:
   a) if contaminated, treat this material as radioactive waste.

b) if not contaminated, remove, or obliterate the radiation labels before discarding in in-house trash.

8. Make a record of the receipt.

7. Transfer of Radioactive Materials:

Transfer of radioactive material between investigators of different projects must be approved by the Radiation Safety Officer (RSO) or Radiation Safety Committee (RSC). These transfers must be between "committee approved" Authorized Users, and within the limits of the approved quantities. The transfer should not take place until authorized by the RSO or the RSC. All transfers must be done in a way that minimizes the probability of spillage or breakage. Double containers must be used, including suitable shielding, for such transfers.

Licensed material shall not be transferred or shipped from one institution to another without the approval of the RSO. Transfer of radioactive material between Authorized Users, or between a User and an outside facility, are permitted as long as such transfers are in compliance with Medical Science Campus license conditions and any other applicable regulatory requirements. Transfer of radioactive material to another institution requires an NRC license to possess that material by the receiving institution, and oversight by the Radiation Safety Officer of the receiving institution. The Radiation Safety Office must be notified before any transfers take place, either between MSC Authorized Users or with outside facilities.

Users must record any transfers on the **Radionuclide Inventory Form. Isotope Inventory in Refrigerator or Freezer.** Any material that is either donated or received free-of-charge (e.g., received on a trial basis or free samples, or samples from other research facilities) must be approved prior to receipt by the RSO or the RSC.

8. Transportation or Shipment of Radioactive Material:

The transportation or shipment of radioactive material on campus and to other institutions, must comply with both State and United States Department of Transportation (USDOT) regulations. Unless specifically exempted by the Radiation Safety Officer, all radioactive shipments and transport within or from the UPR MSC must receive prior approval from the RSC. In addition:

1. Transport of radioactive material off-campus by University of Puerto Rico employees, as checked baggage on public conveyances, is prohibited.
2. Radiation sources (such as x-ray machines, x-ray diffraction systems, analytical units, accelerators, etc.) or equipment containing sealed sources of radioactive material (such as liquid scintillation/gamma counters, gas chromatograph electron capture detectors, moisture content gauges, etc.) shall not be transferred, donated, sold or discarded without notification of and approval by the Radiation Safety Officer.

J. INVENTORY AND RECORDS

The NRC requires that all licensees maintain records tracking the receipt, use and disposal of radioactive materials. This is done with an inventory maintained by the Radiation Safety Office.

Use logs are required in laboratories utilizing unsealed isotopes. The log should contain records of amounts used, who used them and dates of use for each shipment received. Physical inventories are conducted at intervals not to exceed 6 months, to account for all sealed sources and devices received and possessed under the license.

The University is required to maintain accurate, timely records of the receipt, use, transfer, and disposal of radioactive material in its possession. Authorized Users have this same responsibility for their sources. These records must be maintained by the Authorized User for at least three (3) years and be readily available for periodic review by Radiation Safety Office and/or regulatory personnel.

The Radiation Safety Office personnel will compare requisitions with database prior to the authorizing the purchase of radioactive material. Any package that was not approved by the Radiation Safety Office personnel will not be purchased. If a free sample or material is received from another university, the laboratory will notify the Radiation Safety Office personnel within the next business working day. The material cannot be used until the Radiation Safety Office personnel has been notified and authorization has been given to use the material. The Radiation Safety Office personnel will then add the material to the data base and will provide an inventory sheet for the material. If it has been determined that a package was received and the Radiation Safety Office personnel was not informed, the authorized individual will have their radioactive materials suspended. The RSC and the RSO will make this determination.

A number is assigned to each radioactive item/vial logged in through the Radiation Safety Office and is documented in the radioisotope receipt and disposal record.

A receipt of radioactive material and disposal of packing material form will be provided with each vial of radioactive material received by the Authorized User. Attached to this form should be a copy of all the User's packing slips associated with all incoming radioactive material packages.

A disposition sheet to record each use of radioactive material in that specific vial should be available in and updated for each inspection **(Radioisotope Inventory Log Sheet Form).**

The **Isotope Inventory in Refrigerator or Freezer Form** should be completed for each radioactive material receipt.

Transfers to solid and liquid will be updated each month by the Authorized User and will be checked by the Radiation Safety Office personnel. The waste data must be accurate to ensure the University does not exceed the total possession limit for each radionuclide **(Radioactive Waste Pick Up Sheet Form).**

An Authorized User and/or a designee must keep records of all radioactive materials ordered, received, and disposed. The Radioisotope Inventory should be maintained in the laboratory**. Records must be maintained by the AU for a period of 3 years.**

Note: Packing slips must be strictly maintained to keep an accurate inventory. To accurately document the amount of radioactive material used at the workbench, a Radioactive Material Inventory should be maintained. Inventory of then radioactive materials should include the name of the physical/chemical form of the radioactive material, the amount (in millicuries) of radioactive waste, and the net quantity (in milicuries) of the radioisotopes on hand in the laboratory. The date of assay is required for accurately determining the exact activity on hand at

any date. If the date of assay is not provided by the manufacturer, then use the date received in the laboratory as the date of assay and calculate the activity of the radioisotope using this assumption.

K. PERSONNEL MONITORING

Dosimeters -- According to 10 CFR 20.1502 “Conditions Requiring Individual Monitoring of External and Internal Occupational Dose”, personal monitoring devices (dosimeters) are required for workers who may receive 10 percent of the maximum dose of external radiation permissible under NRC's regulations **(Table 2).** To apply for a monitoring device, laboratory personnel must complete a **Request for Radiation Monitoring Badge Form** and return it to the Radiation Safety Office. The RSO will request the dosimetry records of new radiation workers from other institutions where they used radioactive materials. Old and new dosimetry records will be added to obtain cumulative records.

Exposure standards have been established by the NRC and set at a level where apparent injury due to ionizing radiation during a normal lifetime is unlikely. (There are unique standards for minors (< 18 years of age) and pregnant workers. However, personnel should not completely disregard exposures at or below these limits. It is the responsibility of everyone to keep his/her exposure to all radiation as low as is reasonable, and to avoid all exposures to radiation when such exposures are unnecessary.

The exposure limit for whole body exposures is lower than that for a single organ because all organs and tissues are exposed in a whole-body exposure, while only a single organ is involved in the single organ exposure limits. The risk to the organ is incorporated in the exposure calculations, which must be done if organs or tissues are exposed. Occupational limits to external radiation for adult and minor radiation workers are given in the table below.

Table 2. Annual Maximum Permissible Dose Equivalent in mrem

Annual Maximum Permissible Dose Equivalent in mrem			
Part of Body	**Adult Yearly (mrem)**	**Minors Yearly (< 18 yrs. age) (mrem)**	**Adult ALARA Yearly (mrem)**
Whole Body, Head and Trunk, Active Blood Forming Organs **(TEDE)**	5,000	500	500
Lens of Eye **(LDE)**	15,000	1,500	1,500
Extremities **(SDE)** (Elbows, Forearms, Hands, Knees, Lower Legs, Feet)	50,000	5,000	5,000
Single Organ Dose **(TODE)**	50,000	5,000	5,000
Skin of Whole Body **(SDE)**	50,000	5,000	5,000
TLD's will be used for monitoring gamma and high-energy, beta-emitting radioisotopes, such as ^{32}P, ^{51}Cr, and ^{125}I. The Radiation Safety Office may use radiation dosimeters to monitor levels of radiation in laboratories or other areas.			

New dose quantities were incorporated in the 10 CFR 20 law “Standards for Protection Against Radiation” which took effect on 1/1/94. Notice that each of the following quantities are types of dose equivalents. The following definitions describe the new quantities. (Note: the types of doses are quantities; the units used for these quantities are the rem or the Sievert (Sv).

DE: Dose Equivalent. The product of the absorbed dose in tissue, quality factor and all other necessary modifying factors at the location of interest. The units of dose equivalent are the rem and Sievert.

CDE: Committed Dose Equivalent. Means the dose equivalent to organs or tissues of reference that will be received from an intake of radioactive materials, by an individual during the 50 year period following the intake.

EDE: Effective Dose Equivalent. It is the sum of the products of the dose equivalent to the organ or tissue and the weighting factors applicable to each of the body organs or tissues that are irradiated.

CEDE: Committed Effective Dose Equivalent. It is the sum of the products of the weighting factors applicable to each of the body organs or tissues that are irradiated and the committed dose equivalent to these organs or tissues.

DDE: Deep Dose Equivalent. Applies to external whole-body exposure. It is the dose equivalent at a tissue depth of 1 centimeter (1000 mg/cm^2).

TODE: Total Organ Dose Equivalent. The sum of the CDE and DDE for the maximally exposed organ.

SDE: Shallow Dose Equivalent. Applies to the external exposure of the skin or an extremity, is taken as the dose equivalent at a tissue depth of 0.007 centimeter (7 mg/cm^2), averaged over an area of 1 square centimeter.

LDE: Lens of Eye Dose Equivalent. Applies to the external exposure of the lens of the eye and is taken as the dose equivalent at tissue depth of 0.3 centimeter (300 mg/cm^2).

TEDE: Total Effective Dose Equivalent. The sum of the deep dose equivalent (for external exposures) and the committed dose equivalent (for internal exposures).

An accurate record of an employee's radiation exposure history must be maintained in the Radiation Safety Office. Employees must provide information regarding any prior occupational radiation exposure on **Previous Radiation History Data Sheet**. If a worker is occupationally exposed to radiation elsewhere, in addition to being exposed at MSC, the Authorized User should report this to the Radiation Safety Office so that an accurate record of the worker's total radiation exposure can be maintained.

Radiation detection dosimeters are not assigned for investigators who work with certain radionuclides, since the energies are beneath the detection limit of the badge. This is not a risk to the worker, however, because these types of radiation are not penetrating enough to cause a deep radiation dose. Examples of these radionuclides are ^{3}H, ^{14}C, ^{35}S, ^{45}Ca, ^{33}P and ^{63}Ni.

For those individuals who use X-ray equipment and/or high energy beta or gamma emitters, extremity badges (ring), should be used in conjunction with the whole-body dosimeter. It is a legal requirement that workers handling greater than or equal to 1 mCi of ^{32}P must wear extremity badges. The whole-body badge should be worn on the torso with the name tag facing the suspected source of radiation. With finger ring badges, the name tag must face the radiation source.

Employees must wear dosimeters recommended by the Radiation Safety Office while working in any restricted area (see Glossary). While not being worn, dosimeters should be stored away from all radiation sources in a desk drawer or in some other location where they will not be exposed to excessive heat, sunlight, or moisture (for example, never leave in a car). They should not be worn outside MSC premises. Individuals who do not work directly with radioisotopes but work in a laboratory where radioisotopes are used could submit a request for dosimeters.

NOTE: Individuals who wear radiation badges should review their radiation dosimetry records to ascertain their radiation exposures in the radiation laboratory.

Lost or misplaced badges should be reported immediately to the Radiation Safety Office and a report must be handed to receive a replacement (**Radiation Film Badge Report Form).** Under no circumstances should workers wear a dosimeter belonging to another individual. It is a legal requirement that doses be tracked for the worker to whom the dosimeter is assigned.

Any dosimeter contaminated or exposed to heat, moisture, or medical x-rays should be returned to the Radiation Safety Office for replacement. After any accident or if an overexposure is suspected, the dosimeters should be returned immediately to the Radiation Safety Office to be read. Dosimeters should be worn on a shirt, coat pocket, lapel, or in some other position between the waist and the shoulders that will be representative of any radiation exposure. If, during a radiological process, a hand might receive a dose, a ring dosimeter should be worn on a finger of the hand under the glove.

When both whole-body and hand doses occur, two dosimeters will be issued, one for the whole body and one for hand use.

Authorized Users are responsible for distributing and collecting dosimeters for laboratory personnel under their authorization. Ring and whole-body dosimeters will be exchanged quarterly through the Radiation Safety Office. The Radiation Safety Office will keep a record of any dose received and will send each worker a copy of his or her exposure record upon request.

When terminating employment at the MSC, badges must be returned to the Radiation Safety Office and with the corresponding request **(Request for Termination Form).** If badges are not returned and proper notification of termination of employment/study has not occurred, this falls as noncompliance with regulatory requirements. A termination report will be supplied when a worker leaves, since the next place of employment must be supplied with this report before the individual is allowed to work with radioactive materials.

At any time, individuals can contact the Radiation Safety Office for their dosimeter data. It typically takes 4 to 6 weeks to have the badges sent off and processed. The badge vendor will

call the Radiation Safety Office to report any doses that are significantly higher than normal (i.e., greater than 200 mrem on a badge), and the worker will be notified. If you suspect that you have received a significant exposure, contact the Radiation Safety Office immediately. Potential exposure will be evaluated, and the badge may be sent immediately for an emergency reading. Another badge will be issued for the interim period. On an emergency basis, results can be obtained within a few days.

Maximum Permissible Doses -- Federal limits for radiation doses are provided in Table 2; however, all doses must be maintained ALARA.

The maximum permissible dose for persons under 18 years of age is 10 percent of the doses shown in Table 2. At the MSC, employees under 18 years of age are not allowed to use radioactive materials. * Exposure to pregnant women must be controlled so that the fetus will not receive more than 500 mrem during the entire gestation period. The Radiation Safety Office must be informed of any pregnant employees who may be exposed to radiation. The Radiation Safety Office through the RSC and the RSO shall take any action deemed necessary to protect these employees without affecting their employment status.

Internal exposures must be prevented. Work procedures and equipment must be designed to prevent the release of any radioactive substance into room air. Processes that involve volatile or gaseous material or that generate particulates must be confined to an approved fume hood operating with a face velocity of at least 100 lfm or to an approved glove box. Air flow rates on all hoods should be monitored and calibrated at least annually. Uncalibrated hoods should be timely reported to the Radiation Safety Office.

Minors Working With Radioactive Materials:

Radiation exposure limits for minors, (individuals under 18 years of age) who work with radioactive materials:* these limits are 10% of all of the occupational limits for adult radiation workers. For these workers, safety training must be completed prior to work with radioactive materials as with other occupational workers. It is university policy that a parental consent form must be completed and kept on file for liability purposes and risk management.

Due to university policy and legal requirements, Authorized Users must notify the Radiation Safety Office before allowing minors to handle radioactive materials. The Radiation Safety Office will assist with documentation.

Exposure Limits for the General Public:

Visitors to a radiation laboratory who are not classified as radiation workers by their employers, laboratory workers who are not trained in radiation safety, custodial staff, and any other non-radiation workers are all members of the general public under the law. They must not receive a radiation dose more than either:

1. 2 mrem in any one hour.
2. 100 mrem in any one year.

Since most radiation use facilities frequently have members of the general public visit their work areas, MSC has elected to maintain unrestricted area contamination limits as part of the ALARA program.

L. RADIATION EXPOSURE DURING PREGNANCY

A special situation arises when a radiation worker becomes pregnant. Under these conditions, radiation exposure could also involve exposure to the embryo or fetus. Several studies have indicated that the embryo or fetus is more sensitive than the adult, particularly during the first four months of pregnancy. This can be a problem since many workers are unaware of their pregnancy during the first month or two of gestation. Hence, the NRC requires that all occupationally exposed workers be instructed concerning the potential health protection problems associated with prenatal radiation exposure.

Declared pregnant workers (DPW) will be assigned two badges, one for the whole body, normally worn on the torso and one for the fetus, normally worn on the abdomen. The badges will be exchanged monthly. Exposures must be maintained beneath a cap of 50 mrem per month to prevent exposure spikes.

Employees who become pregnant are strongly encouraged to notify her supervisor and the RSO in writing as soon as possible. A description of predicted usage of radionuclides and procedures to be performed during the gestation period should be sent to the RSC and the RSO for evaluation. The RSC and the RSO will inform the pregnant woman and her supervisor of individual actions that may need to be taken to ensure compliance with the 500 mrem rule, i.e. the fetus will not receive more than 500 mrem during the entire gestation period. Medical documentation of pregnancy is not required unless modification of assignment is necessary. If desired, confirmation of pregnancy may be obtained free of charge, through the MSC Occupational Health Clinic. If notification is not made in writing, the radiation exposure limits remain at the occupational level, that is, 5 rem per year. An individual may "un-declare" her pregnancy at any time, but this also should be documented.

ALARA recommendations on pregnancy and radiation exposure include:

1. Notifying of supervisor immediately when pregnancy is known or suspected.
2. Wearing a lead apron while performing work with certain radionuclides.
3. Using extra shielding such as lead-lined waste containers for gamma emitters.
4. Wearing radiation badges (worn at the waist) to be read monthly, not quarterly.
5. Deferring the receipt of unshielded stocks of radionuclides.
6. Leaving work area where more than one millicurie of certain radionuclides are being used.

The 500 mrem value for the fetus does not create a basis for discrimination and should be achieved in conformance with the provision of Title VII of the Civil Rights Act of 1964, as amended, regarding discrimination in employment practices, including hiring; discharge; compensation; and terms, conditions, or privileges of employment.

M. LABORATORY SUPPLIES AND EQUIPMENT

It is each principal investigator's responsibility to provide adequate shielding and monitoring instruments for use with their radioactive material and to ensure adherence to the following regulations by themselves and by all other persons working with their material. The Radiation Safety Office will provide adequate information to the principal investigator to maintain in compliance with the requirements of the NRC and the Broad Scope License of the University of Puerto Rico.

In addition, it is each applicant's responsibility to ensure they have access to a functional fume hood for use of volatile radioactive material. The Radiation Safety Office must be notified when fume hoods used in radioactive material experiments become nonfunctional and should be notified prior to service calls for clogged sinks, nonfunctioning hoods, or filter changes.

The following supplies and equipment are recommended for laboratories where radioisotopes are used:

1. Fume hood with minimum flow rate of 100 linear feet per minute (lfm) (if volatile radioactive solutions are used).
2. Shielding, transparent, acrylic beta shields, acrylic boxes, or lead bricks, when necessary.
3. Laboratory coats, disposable gloves, and protective eyeglasses.
4. Remote pipetting devices and aerosol resistant tips. Preferably, at least one set of pipettes dedicated for radioisotope usage only.
5. Absorbent paper with impervious plastic backing for work areas.
6. Appropriate personnel monitoring badges and finger rings.
7. Appropriate signs and labels for doors, centrifuges, incubators, freezers, refrigerators, hoods, glassware, and other containers holding radioactive substances.
8. Lockable waste containers.
9. Plastic bags (i.e., not "Biohazard") are for radioactive waste disposal.
10. Lockable isotope storage boxes which can be properly secured to refrigerator or freezer.
11. Laboratory record book for maintaining inventories and surveys.
12. Copy of the MSC Radiation Safety Manual.
13. Appropriate, calibrated survey meters and materials for conducting wipe tests.
14. Supplies for keeping the area clean and free of contamination.
15. Posted current NRC Form 3.
16. Clearly labeled spill kit in each room where radioisotopes are used.

N. BIOASSAY

Some laboratory exposures to radiation may occur by the inhalation, ingestion, or skin absorption of radioactive material and may result in internal radiation exposures, which are measured by bioassay methods. These methods look for radioactivity in either the entire body (whole-body count monitoring) or organs or body fluids (such as thyroid count monitoring and urine specimen radioassays).

Since the principles of external protection, i.e. time, distance, and shielding are not applicable, safety measures should be implemented to prevent internal radiation exposures. Work procedures and equipment must be designed to prevent the release of any radioactive substance into room air. Processes that involve volatile or gaseous material or that generate

particulates must be confined to an approved fume hood operating with a face velocity of at least 100 lfm, or to an approved glove box. Air flow rates on all hoods must be monitored and calibrated annually through the Radiation Safety Office; uncalibrated hoods should be reported to the Radiation Safety Office.

Tritium -- Individuals involved in operations that use tritium (^{3}H) in any form other than metallic foil (as in gas chromatography detectors) that are in quantities greater than those listed in Table 3 below must have bioassays performed. Authorized Users must inform the Radiation Safety Office about any workers whose exposure requires periodic bioassay based on these guidelines.

Bioassays for tritium are obtained by urine samples. A baseline sample should be obtained before work with tritium is started. An employee working with quantities exceeding those shown in the table during a single operation shall provide a urine sample within one week after the exposure. An employee who, in one month, works with quantities exceeding those shown in the table shall provide urine samples weekly during the exposure and once after the exposure ends. The Radiation Safety Office may also require urine samples at other times.

Table 3. Bioassay Levels for Tritium

Bioassay Levels for Tritium			
Processing Done	**Tritiated Water or Tritiated Compounds (Ci)**	**Tritium Gas in Sealed Vessels (Ci)**	**Tritiated Water Mixed with More Than 10 kg of Inert Water or Other Substances (Ci/kg)**
In open room with possible escape of tritium	0.01 (10 MilliCuries)	10	0.001
Within fume hood of adequate design	0.10 (100 milliCuries)	100	0.010
Within glove boxes	1.00 (1000 milliCuries)	1000	0.100

Tritium oxides (HTO) can be absorbed into the body through the lungs or through the skin; therefore, unsealed sources of tritium should be used only in a certified fume hood Employees should wear two pairs of protective gloves when working with tritium. Gloves should be changed frequently to prevent the tritium from penetrating over time.

Metal systems should be used, when possible, to reduce breakage and diffusion through stopcock grease. Laboratory equipment used to process tritium should be considered contaminated. If accidental exposure to tritium occurs, the Radiation Safety Office must be informed immediately. A urine sample or samples from the employee(s) involved must be provided as requested.

Iodine-125 and Iodine 131 -- Employees must undergo thyroid monitoring if in one operation or over a 3-month period, they handle open forms of ^{125}I or ^{131}I in quantities which exceed those given in Table 4. For a single operation, monitoring should be done 6 to 72 hours after the exposure; for ongoing exposure to radioiodine, quarterly monitoring is required.

New employees must have baseline thyroid counts measured before beginning work with ^{125} I or ^{131} I. Thyroid monitoring shall also be done when an employee's work with the quantities of radioiodine listed below is completed. Persons whose only radioiodine exposure is through the

use of commercial RIA kits should refer to the second column in Table 4 to determine if they need monitoring.

Table 4. Bioassay Levels for ^{125}I and ^{131}I

Bioassay Levels for ^{125}I and ^{131}I		
	Forms	
Processing Done	**Volatile or Dispersible(millicurie)**	**Bound to a Nonvolatile Agent(millicurie)**
In open room or bench with possible escape from process vessels	0.1	1.0
Within fume hood of adequate design, but with possible escape of iodine	1.0	10.0
Within glove boxes, but with possible leakage or box contamination	10.0	100.0

Bioassay requirements for other nuclides (e.g. ^{32}P) will be determined on a case-by-case basis for those individuals who are likely to receive an intake in excess of 10 percent of the applicable annual limit on intake.

O. LABELING

Definitions:

Restricted area -- An area, access to which is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials.

Unrestricted area -- An area access which is neither limited nor controlled by the licensee.

Radiation area -- An area accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent more than 0.005 rem (0.05 mSv) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

High-radiation area -- An area accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent more than 0.1 rem (1 mSv) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates. NOTE: Such an area is unlikely to be created at CDC. The establishment of such an area requires approval by the RSC and the RSO only after a thorough investigation has been made of the need for and the safety of such an area.

Airborne radioactivity area -- A room, enclosure, or area in which airborne radioactive materials, composed wholly or partly of licensed material, exist in concentrations - (1) In excess of the derived air concentrations (DACs) specified in 10 CFR 20.1001-20.2401, or (2) To such a degree that an individual present in the area without respiratory protective equipment could exceed, during the hours an individual is present in a week, an intake of 0.6 percent of the annual limit on intake (ALI) or 12 DAC-hours.

Labeling Requirements -- Each area or laboratory used to store or contain licensed radioactive material shall be conspicuously posted with a door sign bearing the radiation caution symbol and the words "Caution (or Danger), Radioactive Materials." Containers or areas where radioactive material is stored, used, and disposed of shall bear a durable, clearly visible label that identifies the contents. The label must have the radiation symbol and the words "Caution (or Danger), Radioactive Materials." Beakers, test tubes, and other glassware that contain radioactive material transiently during an experiment need not be individually labeled. However, containers that will be left unattended must be labeled.

Refrigerators and other containers or areas where radioactive materials are stored must be marked with a radioactive materials label.

A current NRC 3 form "Notice to Employees," must be posted so that it can be easily seen by persons entering or leaving a restricted area. Also, names and emergency phone numbers of personnel of the Radiation Safety Office, RSO and Chairperson of the RSC must be posted. Authorized Users are responsible for posting all signs required and/or provided by the Radiation Safety Office. Authorized Users must also remove signs that are no longer needed or that have become incorrect or inappropriate for their laboratories.

P. SURVEYS

Radiation Surveys:

The frequency of surveys depends on the quantity and use of radioactive materials, as well as the specific protective facilities, equipment, and procedures that are designed to protect the worker and members of the public from external exposure to radiation. While the regulations do not specify a specific survey frequency, MSC is required to ensure that the dose rate limits are not exceeded.

Surveys should be sufficient to identify areas of contamination that might result in doses to workers or to the public. Combined removable and fixed contamination should be surveyed using appropriate radiation detection equipment. Removable contamination can be detected and measured through a wipe test of the surface, which is counted in an appropriate counting instrument, such as a liquid scintillation counter, a sodium iodide or germanium gamma counter, or a proportional alpha/beta counter.

Contamination surveys should be performed:

- To evaluate radioactive contamination that could be present on surfaces of floors, walls, laboratory furniture, and equipment
- After each experiment, any spill or contamination event
- When procedures or processes have changed
- To evaluate the potential contamination of users and the immediate work area, at the end of the day or prior to leaving the area of use, when licensed material is used
- In unrestricted areas at frequencies consistent with the types and quantities of materials in use but generally not less frequently than quarterly
- In areas adjacent to restricted areas and in all areas through which licensed materials are transferred and temporarily stored before shipment.

Personnel should survey for contamination in locations where individuals are working with an unsealed form of radioactive material. These surveys should be done at a frequency appropriate to the types and quantities of radioactive materials in use. By doing this, the potential for exposures can be evaluated and reduced, if necessary. Records of these surveys must be maintained for review.

The Radiation Safety Office will make independent surveys of all active radioisotope labs monthly. Such things as inventory assessment, contamination control, personnel monitoring, training and waste disposal practices will be addressed during these surveys.

Copies of the results of surveys will be forwarded to the AU, and a recheck may be conducted in the event problems have been detected that need corrective action. The RSC may accompany the Radiation Safety Office on surveys as deemed necessary for problem laboratories or for purposes of auditing the radiation safety program.

When removable radioactivity is found, the area must be decontaminated and then re-surveyed and documented. Detectable levels of removable contamination should be removed, and non-removable contamination should be labeled and shielded whenever possible in order to maintain ALARA limits.

It is understood that certain areas may be routinely contaminated, such as internal parts of equipment and the inside areas of glassware, and that it may not be practical to decontaminate these surfaces. If this occurs, signs must be posted and protective clothing and gloves should be used when in contact with these areas. In some cases, such as ^{32}P contaminated equipment, shielding is required.

Contamination found in unrestricted areas should be immediately decontaminated to background levels. When it is not possible to get to background levels, the AU must ensure that the amounts of contamination on equipment do not exceed the contamination levels listed in the first table below (taken from Appendix Q to NUREG-1556, Vol. 7, “Program-Specific Guidance About Academic, Research and Development, and Other Licenses of Limited Scope,” dated December 1999).

If the contamination is found on building surfaces, the AU must ensure that the amounts of contamination do not exceed the contamination levels listed in the second table below (taken from Appendix Q to NUREG-1556, Vol. 7, “Program-Specific Guidance About Academic, Research and Development, and Other Licenses of Limited Scope,” dated December 1999). Radioactive contamination found at or above these levels must be decontaminated or shielded and labeled. (Therefore, one of the advantages of using disposable lab paper on the benches is that one only must dispose of the contaminated area of the paper in the radioactive waste, rather than decontaminating or shielding.)

Table 5. Acceptable Surface Contamination Levels for Equipment

Nuclide	Average	Maximum	Removable
I-125, I-129	100 dpm/100 cm^2	300 dpm/100 cm^2	20 dpm/100 cm^2
I-126, I-131, I-133, Sr-90	1,000 dpm/100 cm^2	3,000 dpm/100 cm^2	200 dpm/100 cm^2
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.	5,000 dpm/100 cm^2	15,000 dpm/100 cm^2	1,000 dpm/100 cm^2

Table 6. Screening Values for Building Surface Contamination

Radionuclide	Symbol	Screening levels for unrestricted release (dpm/100 cm^2)
Hydrogen-3 (Tritium)	H-3	1.2×10^8
Carbon-14	C-14	3.7×10^6
Sodium-22	Na-22	9.5×10^3
Sulfur-35	S-35	1.3×10^7
Chlorine-36	Cl-36	5.0×10^5
Manganese-54	Mn-54	3.2×10^4
Iron-55	Fe-55	4.5×10^6
Cobalt-60	Co-60	7.1×10^3
Nickel-63	Ni-63	1.8×10^6
Strontium-90	Sr-90	8.7×10^3
Technetium-99	Tc-99	1.3×10^6
Iodine-129	I-129	3.5×10^4
Cesium-137	Cs-137	2.8×10^4
Iridium-192	Ir-192	7.4×10^4

The tables are not inclusive of all radionuclides, and specifically do not include values for radionuclides that emit alpha particles. The NRC staff is assessing current screening approaches for alpha emitters. The NRC is encouraging the use of site-specific dose assessment based on actual site physical and environmental conditions in the interim period.

Most of the radioisotope use areas on campus are treated as restricted areas and are characterized as locations with controlled access and have proper radiation safety controls in place. Contamination limits for surveys are the controlled and unrestricted area limits, due to the ALARA programs required of licensees.

Contamination Limits:

a. Acceptable Limits:

1. Radiation levels in unrestricted areas shall not exceed 2mRem in anyone – hour or 100 mRem in any one-year. If such areas are found, action shall be taken to eliminate the excessive exposure levels. Additional shielding or relocation of radioactive material may be required.
2. Radiation levels in restricted areas do not apply as personnel are monitored to determine their exposure. Individuals such as housekeeping staff who are not monitored will not be allowed to enter such areas unless a responsible person is present to monitor and limit their activities. Radiation levels shall be reduced to as low as reasonably achievable (ALARA). Radiation Safety staff will assist users and provide advice in achieving this goal.

b. Contamination Limits:

1. If the survey meter readings equal or exceed three times background, the area shall be cleaned until the contamination has been removed or stabilized. Establish background for your laboratory by taking a measurement in an area where radioactive material is not used or stored.
2. If the wipe samples equal to three times background or exceed 2200 DPM/100 square centimeters (which ever is less) for beta and gamma radiation, the area shall be cleaned until the contamination has been removed or stabilized. Establish background for your lab by taking a wipe in areas where radioactive material is not used or stored. This wipe should correspond to the same items (floor vs floor, bench top vs bench top) and not different items (floor vs bench top).

c. Unrestricted area:
–Alpha emiters: 200 dpm 100 cm2
–Beta emiters: 2,000 dpm 100 cm2

d. Restricted areas:
–Alpha emiters: 2,000 dpm 100 cm2
–Beta emiters: 20,000 dpm 100 cm2

e. Personal clothing worn outside restricted area
–Alpha emiters: 200 dpm 100 cm2
–Beta emiters: 2,000 dpm 100 cm2

f. Protective clothing worn only in restricted areas:
–Alpha emiters: 2,000 dpm 100 cm2
–Beta emiters: 20,000 dpm 100 cm2

g. Skin:
–Alpha emiters: 2,000 dpm 100 cm2
–Beta emiters: 20,000 dpm 100 cm2

It is recommended that when samples or surveys reveal an easily detectable amount of activity above background, these areas should be cleaned to remove all radioactive contamination. This action should help prevent the spread of contamination and ingestion of radioactive material by personnel whose hands or clothing could become contaminated.

Q. SURVEY INSTRUMENTS

Geiger-Müeller (G-M) Detector:

Principal investigators using 1 mCi or more of C-14, Na-22, P-32, P-33, S-35, Cl-36, Ca-45, Cr-51, Zn-65, Rb-86, Nb-95, Tc-99m, or I-123 at any one time are required to always have a working survey instrument with a thin-end window or pancake Geiger-Mueller probe in the laboratory. Principal investigators using 1 mCi or more of I-125 at any one time are required to always have a working survey instrument with a low energy sodium iodide crystal probe in the laboratory.

Survey instruments in use must be returned to either Radiation Safety Office or the manufacturer for recalibration on an annual basis. When a new survey instrument is purchased, a copy of the manufacturer's calibration certificate must be sent to Radiation Safety Office.

A report of malfunctioning of survey instrument will be sent from the Radiation Safety Office to the principal investigator. This instrument should be returned to the manufacturer for repair and recalibration. A copy of the manufacturer's calibration certificate must be sent to Radiation Safety Office.

A battery check should be performed each day an instrument is used. If the battery test falls below the battery condition line, the instrument must be taken out of use until the batteries are replaced.

Effective June 1, 1997 an instrument operational check must be performed with a dedicated check source each day an instrument is used. The reading taken must fall within the range limits stated on the side of the instrument. If the reading falls outside the stated range, the instrument must be taken out of use and Radiation Safety Office must be contacted.

R. MONITORING OPERATIONS INVOLVING RADIOACTIVE MATERIALS

Surveying for contamination must be made by the user with a survey meter, or equivalent procedure, at the end of the day when radioactive material has been used. Particular attention should be directed to the hands, shoe soles, lab coats, working surfaces, and the floor in the working area. Due to the potential for contamination of work areas during use of unsealed radioactive materials, it is necessary to monitor as much as possible the operations performed. Work areas should be checked before use to determine background or prior contamination. The survey instrument should be turned on and placed proximal to the work area in order to check radiation levels, and to alarm the worker if radiation levels rise significantly. Hands should be checked frequently for presence of contamination due to splashing or aerosols. At the end of the use of the work area, or each day, work areas should be monitored to determine the presence of contamination. Note that worker clothing and shoes should also be monitored. If contamination is found, the area or equipment must be decontaminated.

Active radiation laboratories where radioactive materials are used will be surveyed by Authorized Users or their designer at end of the day by using wipes or a suitable survey meter. A survey using an instrument such as a GM counter is acceptable if it is sensitive enough to detect the nuclides used. For low-energy beta emitters such as ^{3}H or ^{14}C, contamination surveys should be conducted using wipes, which are counted using a LSC and the results must be documented in the corresponding logbook in units of dpm. Users working with Na-22, P-32, P-

33, S-35, Cl-36, Ca-45, Cr-51, Zn-65, Rb-86, Nb-95, Tc-99m, or I-123 must survey with a thin-end window or pancake Geiger- Müeller (G-M) detector and a wipe test should be performed. Users working with I-125 must survey with a sodium iodide scintillation detector. For ^{125}I, a survey instrument equipped with a low-energy sodium iodide crystal is to be used or wipes may be counted on a gamma counter.

Surveys must be documented with one of the standardized survey forms provided by Radiation Safety Office. The entries on either survey form must show the areas surveyed the date of the survey, the radiation measurements in their correct units, the instrument used and the corresponding model and serial number, decontamination results with the correct units, and the initials of the person or persons performing the survey. This must be documented in the daily journal work sheet and must be available and actualized for the monthly inspections that the Radiation Safety Office personnel performed. The results of laboratory surveys will be recorded **on Daily Radiation Survey Report Sheet.**

A diagram of the laboratory should be made, showing benches, desks, sinks and hoods; each area tested should be numbered. The wipes or counts from survey instruments should be numbered according to this diagram so that any area that becomes contaminated can be readily identified. Areas tested should be representative of where contamination might be expected (e.g, hoods, sinks, and counter tops), as well as some areas where contamination would not be expected.

In addition to routine surveys, laboratories or other potentially contaminated areas must be surveyed:

1. After any spill, leak, fire, or other disturbance in a laboratory.
2. When work with radioactive materials is terminated.
3. Before and after laboratory construction modifications.
4. Before maintenance or removal of any equipment that may have meet radioactive material or that contains radioactive material.

The Radiation Safety Office personnel will do their routine monthly inspections to all the laboratories that use, manages, and dispose radioactive materials. They will also be performing a survey with a GM and a wipe test for any contamination. The results will be documented in a monthly survey report in units of mR/hr or dpm and available at the Radiation Safety Office.

Laboratories with sealed sources will be surveyed at least biannually. The following sealed sources will be surveyed by the laboratorians, with OHS assistance, for leakage and external contamination at least once every 6 months. The sources will also be surveyed before and after they are moved within a laboratory or to another laboratory, after being dropped or otherwise damaged, and before and after maintenance:

NOTE: Maintenance, repair, cleaning, replacement, and disposal of GC foils contained in detector cells shall be performed "only" by the device manufacturer. Transfer of GC units or foils off site or on site must be coordinated through the Radiation Safety Section.

Table 7. ***Laboratory Surveillance Frequency***

Survey Category	Activity Range	Survey Frequency
Very Low	<0.01 mCi	Once a month
Low	0.01 mCi to 1 mCi	Every 2 weeks (Or more frequently at the discretion of the Authorized User)
Medium	>1 mCi to 10 mCi	After each operation
High	> 10 mCi	After each operation
Modifying Factors		***Factors**
Simple storage		x 0.01
Very simple wet operations (e.g., dilutions of stock solutions, RIA's done with kits)		x 0.1
Normal chemical operations (e.g., in vitro viral, bacterial, or cell labeling and simple analysis, such as by gel electrophoresis or counting in gamma - or beta counters)		x 1
Complex wet operations (e.g., radiolabeling of nucleic acids, proteins, etc.:in vitro viral, bacterial, or cell labeling and complex analysis, such as zonal centrifugation or extractions)		x 10
Simple dry operations (e.g., manipulation of powders) and work with volatile radioactive compounds (e.g., I-125)		x 10
Exposure of nonoccupational persons		x 10

*The objective is to determine how often to survey the laboratory. To do this, multiply the number of milliCuries of isotope used by the appropriate modifying factor to determine the applicable activity range for purposes of surveillance frequency.

EXAMPLE 1: A protein is to be labeled with 1.5 mCi I-125. The modifying factor of 10 multiplied by 1.5 mCi equals 15 mCi or the activity range > 10 mCi. Factor 10 comes from the procedure being classified as a complex wet operation or being classified as work with volatile radioactive compounds. Thus, the laboratory should be surveyed immediately after the labeling procedure.

ALSO NOTE: The laboratorian performing the procedure with I-125 must have a thyroid scan after the operation if the conditions so indicate this (see Table 7).

EXAMPLE 2: An in vivo labeled virus preparation containing 500 uCi H-3 uridine to be purified by large-scale separation in a zonal or continuous flow rotor with a rotating seal assembly. This is classified as a complex wet operation. Multiplying the number of milliCuries actually used (0.5) by the modifying factor 10 gives an activity range of 5 mCi. This value falls within the 1 mCi to 10 mCi range requiring a survey be performed after each operation with the radioisotope.

Any instrument used for surveys must be calibrated for the specific radioisotope in question at least annually. Calibration curves and records of calibration will be available for all instruments used by radiation workers and OHS. When necessary, the OHS will supply survey instruments to Authorized Users for monitoring radiological procedures.

Action levels for decontamination are shown in Table 8.

Table 8. Actions Levels for Decontamination
Beta and Gamma Emitters

Smear Results	Action
100 dpm/100cm^2	No action required by RSO. Left to discretion of Authorized User.
100-350 dpm/100 cm^2	Area or surfaces should be cleaned as soon as possible by the Authorized User or laboratory personnel. Shoe covers and step-off pads shall be used if contamination is on floor.
350-2,000 dpm/100 cm^2	Contamination should be cleaned immediately under supervision of OHS. Shoe covers and step-off pads are required for entry into the area. Only essential personnel will have access.
2,000 dpm/100 cm^2	Air flow should be shut off. Entry of personnel into the area should be prevented until a representative of OHS arrives. Cleanup should begin immediately by Authorized user under supervision of RSO. Shoe covers and step-off pads are required.
cm^2 = square centimeters (100 cm^2 = 4"x 4")	

Cleanup must be undertaken by Authorized Users or laboratory personnel, not by custodial workers.

Every month, the Radiation Safety Office personnel will perform surveys of laboratories that use radioactive materials as a quality control measure. The Authorized User designer is responsible for making laboratories or other areas accessible for surveys by the Radiation Safety Office.

S. RADIOACTIVE WASTE DISPOSAL

At MSC all disposal of radioactive waste must be authorized by the RSO. All radioactive waste shall be separated from non-radioactive waste. All radioactive waste must be collected for proper disposal. Contact the Radiation Safety Office for radioactive waste pickup arrangements.

The issue of radioactive waste disposal is very complex, due not only to the radioactive nature of the waste and its inherent disposal problems, but also the recent concerns with the chemical hazards associated with the same waste. Hence, it is possible to have mixed waste, which contains not only radioactive waste, but RCRA (Resource Conservation and Recovery Act) hazardous chemical waste. Some liquid scintillation fluids are an example because they contain toluene or benzene, which is hazardous under the RCRA laws, due to flammability and toxicity. Consequently, radioactive waste must be properly manifested for the isotope and activity, and any other hazardous constituents, including chemical or biohazardous components. Consult with the Radiation Safety Office when planning your research. It may not be economically reasonable to do certain experiments due to the associated waste disposal costs.

Radioactive waste is any waste that contains or is contaminated with radioactive material. This includes liquids, solids, animals, used scintillation counting liquids (LSC) etc. Consult with the Radiation Safety Office in the early planning stages of experiments to develop waste minimization strategies and discuss waste disposal procedures.

Radioactive waste must never be placed in any non-radioactive waste container. The RSO will not approve any disposal of radioactive waste through the sink. No general (non-radioactive)

waste may be disposed of in radioactive waste containers. Radioactive waste must never be placed in the corridor or any public areas.

All radioactive waste must be labeled with the appropriate label (Radioactive Waste Label) stating the radioisotope name, activity, date of disposal, and the Radiation Worker's full name and telephone number according to NRC law . Tags must always be filled out after any radioactive waste is placed in the designated storage area in the lab. All individual plastic containers, scintillation vials, bags and bottles of radioactive waste must be tagged with this label. Bench top waste containers are considered part of the experiment, and must be labeled with the isotope, activity in dpm or µCi, and the date.

Records of radioactive waste disposal must be maintained by the University for NRC review, so this labeling is critical. A Radioactive Waste Disposal Log should be used to compile a list of the radioisotopes disposed of in the waste cans.

It is the responsibility of the Principal Investigator to supply primary and secondary containers to prevent the waste from leaking or contaminating surfaces. All radioactive waste must be stored in appropriate containers until its disposal, and the integrity of the waste containers must be assured. All radioactive waste must be secured against unauthorized access or removal. Laboratories must supply their own shielding for waste that may cause external exposures to workers in the area. To dispose of waste under the current regulatory constraints, it is necessary to segregate all radioisotopes from each other (except ^{3}H and ^{14}C), and to segregate chemically hazardous waste from other radioactive waste. It is prudent that workers only place waste which is contaminated with radiation in the radioactive waste containers to control waste disposal cost.

All radioactive waste containers must be locked and secured. Consult with the Radiation Safety Office to obtain appropriate lockable waste and waste storage containers.

Radioactive waste pickup must be scheduled by calling the Radiation Safety Office or sending an e-mail requesting the service. The following information is needed to schedule a pickup:

1. Name of Radiation Worker and phone number.
2. Location of waste (building and laboratory number).
3. Type of waste (liquid, solid, carcasses, LSC vials, etc.).
4. Radionuclide(s) in waste.
5. Any special handling instructions.

The Radiation Safety Office will assist Authorized Users in obtaining an appropriate radioactive waste storage container for each isotope used in the laboratory. Each waste container will be used for disposal of ONE radioisotope ONLY, except for dual labeled radioisotope experiments. Disposal procedures for these containers will be based on the longest half-life. The radioactive waste cans should be stored in an area within the laboratory where they will not be knocked over, used for other waste, or accidentally mistaken as cans for non-radioactive waste. Authorized Users and Radiation Workers are responsible for securing waste until the Radiation Safety Office removes it.

Disposal of Radioactive Waste:

Due to the problems in radioactive waste management and legal requirements, no radioactive waste may be removed from the laboratory without the complete information on the tag. Chronic failure to thoroughly manifest radioactive waste may result in suspension of permission to use radioactive materials. MSC currently manages radioactive waste by one or more of the following methods as directed by the Radiation Safety Office:

1. Decay-in-storage (DIS)
2. Transfer to an authorized recipient

1. Procedure for disposal by Decay-In-Storage (DIS):

- Only short-lived waste (physical half-life of less than or equal to 90 days) may be disposed of by DIS.
- Short-lived waste should be segregated from long-lived waste (half-life greater than 90 days) at the source.
- Waste should be stored in suitable well-marked containers, and the containers should provide adequate shielding.
- Liquid and solid waste must be stored separately.
- When the container is full, it should be sealed. The sealed container should be identified with a label affixed or attached to it.
- Contact the Radiation Safety Office for waste pickup.
- The contents of the container should be allowed to decay for at least 10 half-lives of the longest-lived radioisotope in the container.
- Prior to disposal as ordinary trash, each container should be monitored as follows:

    - Check the radiation detection survey meter for proper operation.
    - Survey the contents of each container in a low background area.
    - Remove any shielding from around the container.
    - Monitor all surfaces of the container.
    - Discard the contents as ordinary trash only if the surveys of the contents indicate no residual radioactivity, i.e., surface readings are indistinguishable from background.
    - All radioactivity labels must be defaced or removed from containers and packages prior to disposal of ordinary (non-radioactive) waste. If waste is compacted, all labels that are visible in the compacted mass must be defaced or removed.
    - If the surveys indicate residual radioactivity, return the container to the DIS area.
    - If the surveys indicate no residual radioactivity, record the date when the container was sealed, the disposal date, type of waste (used or unused material, gloves, etc.), survey instrument used, and the initials of the individual performing surveys and disposing of the waste.

2. Procedure for disposal by transfer to an authorized recipient:

- The Radiation Safety Office is responsible for finding an appropriate company for waste disposal.

Quantifying Levels of Radioactivity in Waste:

Radioactive and other hazardous materials must be completely manifested in the waste. To accurately list levels of radioactivity on the tags, it is necessary to assess the levels which are disposed in both liquid and solid waste. Suggestions on methods to quantify the waste follow.

1. During a given experiment it is known that a certain quantity of radionuclide is used. At the end of each of several similar experiments, take a sample of liquid waste and count it with the appropriate counting equipment (LSC). The activity in the sample per unit volume is then multiplied by the total volume of the liquid waste generated. For the solid waste, the quantity of radioactivity in the liquid is subtracted from the total quantity used in the experiment, and the remainder is then the quantity in the solid waste.

Example:

Total Used in Experiment (corrected for age): 500 µCi
Liquid Sample Volume: 1 ml
Total Liquid Waste Volume: 4000 ml
Activity in Liquid Waste Sample: 8 E-2 µCi/ml
Liquid Waste Total Activity: 8 E-2 µCi/ml X 4000 ml. = 320 µCi in liquid waste
Solid Waste Total Activity: 500 µCi - 320 µCi = 180 µCi in solid waste

2. After the first few experiments, or when the waste carboy is full, take a sample of the pooled liquid waste, and count it as above. Multiply the activity of the sample per unit volume by the total volume in the carboy to obtain the total activity in the carboy. Quantify the solid waste as above by subtracting the liquid waste activity.

Multi-hazard Waste --This is waste that contains any combination of radioactive, biohazardous, and chemically hazardous materials known as mixed waste. **Avoid creating such materials, if possible!** Disposal of multi-hazard-waste is extremely costly and difficult.

Solid Waste -- This includes test tubes, beakers, absorbent paper, gloves, pipettes, and other dry items contaminated with radioactive material but not containing liquid radioactive waste. This material must be placed in plastic bags, sealed with tape. Hypodermic needles, capillary pipettes, and other sharp objects must be placed in puncture-proof containers before being put into the large waste cans.

Containers bearing a radioactive label, but no longer containing radioactive material must be disposed of as ordinary waste only after the radioactive label is defaced or removed and after being decontaminated.

Before any radioactive material contaminated with a microbiological organism (virus, fungus, or bacteria) is disposed of, it must be chemically treated in a manner that destroys all living organisms (e.g., with fresh 10 percent bleach solution). Autoclaving or Gamma cell irradiation should be used only when necessary. Care should be taken to protect autoclaves from any radioactive contamination, particularly tritium, and radioiodine's.

Before animal experiments with radioisotopes can begin, animal protocols must be approved by the Animal Use Committee (IACUC) and the Radiation Safety Office must be consulted so that proper arrangements can be made for disposal of radiologically contaminated or infectious carcasses. Animals that contain less than 0.05 microcurie of ^{3}H or ^{14}C per gram can be

disposed of as biological waste. At concentrations higher than this or for other radioisotopes, the animal or tissues must be disposed of as radioactive waste.

Organic Liquid Waste -- Scintillation vials that contain less than 0.05 microcurie of ^{3}H or ^{14}C per gram of scintillation medium should be disposed of as chemical waste and not as radioactive waste. All scintillation vials containing radioactivity above these levels must be labeled as radioactive waste. Scintillation fluid and radioactive waste must be left in the original vials for disposal. These vials should be placed upright in shipping trays rather than in the large waste cans or plastic bags. Organic solvents that are insoluble, flammable, or toxic must be collected in inert, airtight plastic bottles and must never be disposed through the sink. The RSO shall oversee the disposal of any aqueous liquid waste that will be picked up from radiation laboratories by Radiation Safety Staff or their representative.

Aqueous Liquid Waste -- No liquid radioactive waste shall be disposed of by the sewage system.

The sink must always be a point of survey when performing decontamination lab surveys.

Liquid radioactive waste must be stored in appropriate containers. RIA kits containing ^{125}I should be treated as radioactive waste and will be disposed of by the Radiation Safety Office.

T. LEAK TEST OF SEALED SOURCES

Leak tests will be performed at the intervals approved by NRC or an Agreement State. Leak tests will be performed by personnel of the Radiation Safety Office according to the sealed source or plated foil manufacturers (distributors) and kit supplier's instructions. As an alternative, we will implement the model leak test program published in Appendix R to NUREG-1556, Vol. 7, "Consolidated Guidance about Materials Licenses: Program-Specific Guidance About Academic, Research and Development, and Other Licensees of Limited Scope" dated December 1999.

The Radiation Safety Officer shall ensure that leak tests and physical inventories are performed on those sealed sources specified and at the intervals specified in the applicable radioactive material license condition or applicable regulations.

The responsible Authorized User shall ensure that:

1. the Radiation Safety Officer is notified prior to the acquisition, transfer, relocation, loss, destruction, or disposal of any sealed source.
2. all sealed sources under the Authorized User's control are secured against unauthorized access or removal.
3. a complete inventory of all sealed sources under the Authorized User's control is maintained and kept available for inspection by Radiation Safety.

This program is as follows:

- For each source to be tested, list identifying information such as manufacturer, model number, serial number, radionuclides, and activity.

- If available, use a survey meter to monitor exposure.
- Prepare a separate wipe sample (e.g., cotton swab or filter paper) for each source.
- Number each wipe to correlate with identifying information for each source.
- Wipe the most accessible area (but not directly from the surface of a source) where contamination would accumulate if the sealed source were leaking.
- Select an instrument that is sensitive enough to detect 185 becquerels (0.005 microcurie) of the radionuclides and ensure that its calibration is current.
- Using the selected instrument, count and record background count rate.
- Calculate efficiency.
- Count each wipe sample; determine net count rate.
- For each sample, calculate and record estimated activity in becquerels (or microcuries).
- Sign and date the list of sources, data, and calculations. Retain records for 3 years (10 CFR 20.2103(a) “Records of Surveys”).
- If the wipe test activity is 185 Bq (0.005 µCi) or greater, notify the RSO, so that the source can be withdrawn from use and disposed of properly.

The sealed and foil source(s) shall be tested for leakage and/or contamination at intervals not to exceed 6 months. Any source received from another person which is not accompanied by a certificate indicating that a test was performed within 6 months before the transfer shall not be put into use until tested.

Notwithstanding the periodic leak test required by this condition, any licensed sealed source is exempt from such leak tests when the source contains 100 microcuries or less of beta and/or gamma emitting material or 10 microcuries or less of alpha emitting material.

Any source in storage which has not been used needs to be tested every ten years. When the source is removed from storage for use or transferred to another person, it shall be tested before use or transfer.

The test shall be capable of detecting the presence of 0.005 microcurie of radioactive material on the test sample. If the test reveals the presence of 0.005 microcurie or more of removable contamination, the source shall be removed from service and decontaminated, repaired, or disposed of in accordance with NRC regulations. A report shall be filed within 5 days of the date the leak test result is known with the NRC. The report shall specify the source involved, the test results, and corrective action taken. Records of leak test results shall be kept in units of microcuries and shall be maintained for inspection by the NRC. Records may be disposed of following NRC inspection.

U. RADIATION SAFETY RULES

1. Eating, drinking, smoking, and the application of cosmetics are prohibited in a room where radioactive materials are used or stored.
2. Protective gloves shall be worn when handling contaminated or potentially contaminated items.
3. Pipetting radioactive solutions by mouth is prohibited.
4. Persons with open wounds should be particularly careful when working with radioactive materials (the wound should be properly covered).
5. Disposable absorbent pads and remote handling devices shall be utilized whenever possible.
6. Hands should be washed thoroughly after handling radioactive materials, especially before eating.

7. Food items shall not be stored in areas or equipment designated for radioactive materials.
8. Personnel monitoring badges shall be worn in restricted areas, as applicable.
9. Radioactive waste shall be kept in labeled containers.
10. Stock shipments shall be handled and stored in specially designated locations.
11. Good housekeeping shall always be maintained. Contamination/spills shall be cleaned up immediately.
12. Follow the established emergency procedures in the case of an accident.
13. Conduct radiation meter surveys after each use and wipe test surveys frequently (document at least monthly). When measurements are abnormal, find the cause and correct.
14. When using volatile radionuclides (e.g. iodine) or heating radioactive solutions, always perform work in a properly operating fume hood.
15. Transport radioactive materials in such a manner as to prevent spillage or breakage and ensure adequate shielding.
16. Label all containers of radioactive materials, including radionuclide, amount, and date. All containers except those in immediate use must be labeled.
17. Utilize shielding when necessary to maintain radiation levels as low as reasonably achievable (ALARA).
18. Store radioactive material in locked cabinets/refrigerators or keep the laboratory door locked when lab personnel are not present.

V. CLEAN LABORATORY CONDITIONS AND CONTAINMENT

Good housekeeping is an important component of laboratory safety. Sloppy work habits, incorrect procedures or shortcuts, lack of containment, crowded or cluttered work areas and similar situations may cause or contribute to accidents or contamination. The following practices will assist in maintaining effective safety.

1. Maintain neat and clean work areas. Clutter, debris, and crowded conditions interfere with the careful handling required in hazardous materials use.

2. Follow experimental procedures carefully. Radioisotope approvals are contingent upon following the procedures, statements and representations made in the Authorized User's approval. Departures from the procedures may place the approval in jeopardy.

3. Use absorbent poly-backed laboratory paper, with the plastic side down, to protect surfaces from inadvertent spills or splashes. Laboratory benches, fume hoods, trays containing samples, waste areas and floors in the radioactive work areas are some of the locations where absorbent paper is useful.

4. Use secondary containment for all radioactive solutions, samples, liquid waste or any other hazardous materials which may be spilled. Use trays, boxes, bus trays and other types of secondary containment to catch spills, splashes, and possible container ruptures.

5. When transporting radioactive materials, use a cart; this will prevent accidentally dropping or tipping the container.

6. Clean up the work areas and survey for contamination after work is finished. If contamination is present, decontaminate or dispose of the contaminated materials.

7. Use tightly sealed or capped containers when moving, heating, centrifuging or vortexing. Spills, evaporation, gases, container breakage or splashes may occur in any procedure where energy is put into the system.

8. Label all radioactive materials and areas where radioactive materials are used, stored, or disposed of.

9. Identify a specific area in the freezer or refrigerator with radioactive labels where radioactive material will be stored. The surface of the plastic containers with the stock solution inside should be identified with radioactive symbols and should always be visible. The freezer or refrigerator should be well organized for inspections.

Housekeeping:

Because supervision of general or shared facilities is usually limited or lacking, responsibility for the condition of the room and its equipment is the responsibility of the principal investigator. The exception is the floor care, which custodians do periodically. Laboratory personnel should keep the rooms well organized and clean. Custodial personnel should not clean floors without the approval from the principal investigator. The principal investigator must arrange times that both is convenient for the laboratory staff and not hazardous to the custodians. All chemicals, biological, and radioactive materials must be secured from being accidentally disturbed or relocated by the custodians.

- Do not order more supplies than are needed. Do not use the floor as a storage area for supplies.
- Laboratory personnel are responsible for cleaning up spills of hazardous materials from counters and floors and picking up razor blades, pipette tips, and other sharps from the floor before allowing the custodians to sweep, mop, or refinish the floors.
- If items need to be moved, the laboratory personnel must move the items to allow the custodians to perform their duties.

Maintenance personnel:

They should only enter laboratories when laboratory staff are present. All possible hazards must be removed from the area before any work is performed. Contact the Laboratory Safety Office if items contain a chemical, biological, or radioactive hazard prior to the start of work.

W. RADIONUCLIDE USE INVOLVING ANIMALS

Before allowing an individual to care for animals used in studies with or treated with licensed material, the Radiation Safety Officer (RSO), Authorized User (AU), and/or veterinarian must ensure that he or she has sufficient training and experience to maintain ALARA doses, control contamination, handle waste appropriately, etc.

The principal investigator, under whose application the material is obtained, is responsible for posting each cage with a sign bearing the standard radiation caution sign, radionuclide, total activity in each animal, date, and name of experimenter. To minimize the spread of contamination, animals used in studies with or treated with licensed material should be housed

in cages or stalls separate from other animals. The facilities, stalls, or cages shall be secured to prevent unauthorized access to the animals. Individuals caring for these animals should reduce the chance of personal contamination by wearing gloves, lab coats, and eye protection, appropriately. They should monitor themselves before leaving the area, particularly their hands and the soles of their shoes. Lab personnel are responsible for conducting area surveys after experiments as prescribed in the laboratory survey section.

Principal investigators and authorized personnel must have access to rooms housing animals injected with radioactive material. Animal housing facilities for animals containing radioactive materials must always be locked.

Special care should be observed when cleaning the cage or stall. The cage or stall, the bedding, and waste from the animal may contain radioactive material. Animal Care Facilities, cages, animal carcasses, waste, bedding/excreta, and related equipment must be held by the investigative staff until the Radiation Safety Office has surveyed for release to the Animal Resource Staff.

Disposal of laboratory animals that contain radioactive material requires special procedures. Animal carcasses that contain less than 1.85 kBq/gram (0.05 micro curies/gram) of carbon-14, or hydrogen-3 may be disposed of by the same method as non-radioactive animal carcasses. Animal carcasses that contain byproduct material with a half-life of less than 120 days may be allowed to decay-in-storage in a freezer dedicated for radioactive material. Animal carcasses must be held for a minimum of 10 half-lives of the longest-lived isotope. After 10 half-lives, the animal carcasses may be disposed as non-radioactive, if radiation surveys (performed in a low background area and without any interposed shielding) of the carcasses at the end of the holding period indicate that radiation levels are indistinguishable from background.

Investigative staff may be issued additional protection and control instructions from the Animal Resource Committee, Radiation Safety Committee and/or the Radiation Safety Office. The Research Group will be required to follow these instructions.

Research Animal Approval:

The administration of radioactive material to research animals and the irradiation of research animals must be approved by the Institutional Animal Care Use Committee (IACUC) and the Radiation Safety Committee.

General Policies:

1. Injection of radioactive material into animals, when appropriate, shall be performed in trays lined with absorbent material.
2. Cages must be labeled as to radionuclide, quantity of radionuclide administered per animal, date of administration, and authorized user.
3. Special procedures must be developed in relation to the collection and disposition of the animal's excreta and carcasses.
4. Any live animals containing radioactive material being returned to the Vivarium shall have prior approval of the Division of Laboratory Animal Resources and the Radiation Safety Officer.

Part 2. Emergency Procedures

I. Role of the Radiation Safety Office:

The Radiation Safety Office will investigate all accidents, spills, fires, or other incidents in which radiological material is involved. In the event of an accident, the Radiation Safety Office will assist by providing technical advice and by monitoring personnel.

The Radiation Safety Office, through the Radiation Safety Officer (RSO), the Radiation Safety Committee, and the Occupational Health Clinic (CASSO), have the responsibility to plan and arrange emergency medical care for victims contaminated with radioactive material or overexposed to radiation at MSC facilities. The Radiation Safety Office will ensure that procedures for emergency care, a list of telephone numbers, and contacts are made available to all Authorized Users.

II. General Emergency Procedures:

All users of radioactive materials should be familiar with these procedures before any emergency arises. When an accident involving radioactive materials occurs, address the greatest hazard first. Lifesaving measures always take precedence over decontamination or other concerns. Advise personnel working nearby of any hazard or accident as soon as possible and prevent them entering the hazardous area. In case of an incident or accident notify the Office of Laboratory Safety in Research and RSO immediately at telephones:

RSO direct line (787) 766-3062;
Office for Laboratory Safety in Research: 1687, 1688, Occupational Health Officers)

III. Specific Emergency Procedures:

b. Spills

Handling Radioactive Incidents/Emergencies:

Incidents may occur during the use of radioactive materials, such as spills, accidental releases into the air, contamination of the worker or the work area, and numerous other possible problems. When an incident occurs, the worker must first make a judgment as to whether the incident is a minor incident, major incident, or emergency. Subsequent actions are based on this decision.

A minor incident with radioactive materials is an abnormal occurrence involving low amounts of radioactive materials, where the worker handling the spill knows how to clean it up, has the decontamination materials on hand, and can respond without incurring risk of exposures or spreading within a reasonably short time. Notify the RSO promptly for assistance at (787) 772-8300, X-1302.

A major incident is an abnormal occurrence involving high amounts of radioactive materials, high risk nuclides, large, contaminated areas, contamination of the skin, airborne radioactivity, or any situation where contamination may have been spread outside the authorized area. Major spills must be reported to the RSO or his/her designee immediately, as required by federal law.

Call the RSO during working hours on (787) 772-8300, X-1302; dial 911 during nonworking hours.

An emergency is an incident which involves serious injury or death, fire, explosion, or significant release of a health or life-threatening material, which is or may be coupled with a minor or major radiological incident. **DIAL 911 ON A CAMPUS PHONE IMMEDIATELY IF AN EMERGENCY HAS OCCURRED!!**

In the event of an **EMERGENCY** in which radioactive materials are involved, the following procedure should be instituted:

1. Notify all persons in the area that an EMERGENCY has occurred and evacuate the area if a risk to all personnel present exists.
2. Dial 7911 on a campus phone and NOTIFY the nature of emergency, using the reporting guidelines previously listed in this section.
3. AWAIT THE EMERGENCY RESPONDERS who will assist and provide direction, as well as contact any other necessary responders.
4. Allow no one to return to work in the area unless approved by the RSO.

All incidents involving radioactive materials must be reported as soon as possible to the Authorized User. If the Authorized User is not available, notify the RSO, who will advise and assist with the problem. The provisions for responding to spills and other contamination events must cover any unique properties of accelerator-produced radionuclides or discrete sources of Ra-226 that the applicant possesses. These radioactive materials are now included in the definition of byproduct material because of the EPAct. When producing PET radioactive drugs, the procedures should also address spills or loss of control of curie quantities of material.

Model Spill/Contamination Procedures – Low- and High-Dose Unsealed Sources (This now includes spills of and contamination from accelerator-produced radioactive materials or unsealed discrete sources of radium-226)

This model provides acceptable procedures for responding to medical use emergencies. This model meets the requirements of 10 CFR 20.1101.

In the event of a **MINOR SPILL Spills of Liquids and Solids (this now includes spills of or contamination from accelerator-produced radioactive materials or discrete sources of radium-226),** these procedures should be followed:

1. Notify the Authorized User and persons in the area that an incident has occurred.
2. Put on protective clothing, such as shoe covers, a lab coat and booties and gloves before starting containment and clean up of the spill using the absorbent paper.
3. Contain the spill. Cover with absorbent paper or dike with absorbent. Paper should be dampened if solids are spilled.
4. Carefully fold the absorbent paper with the clean side out and place in a bag labeled “caution radioactive material” for transfer to a radioactive waste container. Also put contaminated gloves and any other contaminated disposable material in the bag.
4. Isolate the area to prevent unnecessary spread and personnel exposures.
5. Survey using the appropriate monitoring equipment to evaluate the presence of contamination on an individual's skin and clothing and on lab equipment. If skin or clothing

contamination is present, a major spill has occurred. Have someone who is not contaminated call the Radiation Safety Office immediately.

6. To localize the contamination, wipe inward toward the center of the spill.
7. Using disposable gloves carefully fold up the absorbent paper and pad and deposit in an appropriate bag labeled “caution radioactive material” for transfer to a radioactive waste container. Also put contaminated gloves and any other contaminated disposable material in the bag.
8. Survey the area with a low-range radiation detection survey instrument sufficiently sensitive to detect radionuclide. Check for removable contamination to ensure contamination levels are below trigger levels. Check the area around the spill to determine the extent.
9. Decontaminate the spill using decontaminant detergent (available from RSO), and resurvey.
10. Continue step #8 until the area is decontaminated completely.
11. If you leave the contaminated area, remove your gloves, shoes, and laboratory coat; segregate them as radioactive waste before leaving the laboratory.
12. After removing protective clothing, wash all contaminated areas of skin thoroughly, without vigorous scrubbing, with cool water and mild soap for five to ten minutes. Do this as soon as possible after the accident. Be careful not to contaminate yourself after you have thoroughly washed.
13. Document spill in radiation survey logbook.
14. Notify the RSO promptly and report the incident to the RSO.
15. Allow no one to return to work in the area unless approved by the RSO.

In the event of a **MAJOR SPILL of Liquids and Solids (this now includes spills of or contamination from accelerator-produced radioactive materials or discrete sources of radium-226),** the following procedures should be instituted:

1. Notify all persons in the area that a major spill or incident has occurred and vacate unnecessary personnel from the room. Notify the Authorized User.
2. If possible, prevent the spreading of radioactive material by using absorbent paper. Paper should be dampened if solids are spilled. Do not attempt to clean it up. To prevent the spread of contamination, clearly indicate the boundaries of the spill and limit the movement of all personnel who may be contaminated.

3. Shield the source if possible. Do this only if it can be done without further contamination or a significant increase in radiation exposure.
4. Close the room and lock or otherwise secure the area to prevent entry. Post the room with a sign to warn anyone trying to enter that a spill of radioactive material has occurred. Attempt to prevent further contamination or spreading to unrestricted areas. (Hallways, non-radiation laboratories, etc., are unrestricted areas.)
5. Notify the RSO immediately if the spill occurs during normal work hours. Call MSC Police, 911 on a campus phone, after normal working hours.
6. Remove all contaminated clothing and await instructions concerning cleanup from the RSO.
7. If skin contamination has occurred, measure levels of contamination with a survey meter, record, and begin decontamination by gentle washing with warm water and mild soap, washing downwards towards extremities, not upwards. If contamination remains, the RSO may consider inducing perspiration. Then wash the affected area again to remove any contamination that was released by the perspiration.
8. Allow no one to return to work in the area unless approved by the RSO.

Table N.1 is general guidance to determine whether a major spill/contamination procedure or a minor spill/contamination procedure will be implemented. All spills/contaminations of radium-226 will be considered major spills. Estimate the amount of radioactivity spilled. Initiate a major or minor spill/contamination procedure, based on the following information. Spills above these mCi amounts are considered major, and below these levels are considered minor. Spills involving curie quantities of PET radionuclides should initially be considered major spills; either downgrade to a minor spill after decay or restrict access pending complete decay.

Table N.1 Relative Hazards of Common Radionuclides			
RADIONUCLIDE	**MILLICURIE**	**RADIONUCLIDE**	**MILLICURIE**
P-32	1	Tc-99m	100
Cr-51	100	In-111	10
Co-57	10	I-123	10
Co-58	10	I-125	1
Fe-59	1	I-131	1
Co-60	1	Sm-153	10
Ga-67	10	Yb-169	10
Se-75	1	Hg-197	10
Sr-85	10	Au-198	10
Sr-89	1	Tl-201	100

Estimate the amount of radioactivity spilled. Initiate a major or minor spill/contamination procedure, based on the following information. Spills above these mCi amounts are considered major, and below these levels are considered minor. Spills involving curie quantities of PET radionuclides should initially be considered major spills, either downgrade to a minor spill after decay or restrict access pending complete decay.

K. Methods of Decontamination

Spill/Contamination Kit

Assemble a spill/contamination kit that may contain the following items:

- Disposable gloves and housekeeping gloves,
- Disposable lab coats,
- Disposable head coverings,
- Disposable shoe covers,
- Roll of absorbent paper with plastic backing,
- Masking tape,
- Plastic trash bags with twist ties,
- “Radioactive Material” labeling tape,
- Marking pen,
- Pre-strung “Radioactive Material” labeling tags,
- Contamination wipes,
- Instructions for “Emergency Procedures,”
- Clipboard with copy of Radioactive Spill Report Form,
- Pencil, and
- Appropriate survey instruments, including batteries.

Liquid Radioactive Decontaminant: Concentrated liquid decontaminating agents are available from most scientific suppliers. This detergent is diluted with water and rapidly and easily cleans radioactive contamination without excessive effort. Mild wiping or scrubbing will remove most contamination using this detergent. Note that these detergents contain a carcinogen, so the Material Safety Data Sheet should be read by new radiation users so that they are aware of the hazards. In dilute liquid form, radioactive decontaminants do not present a significant hazard to handlers unless ingested or splashed in eyes. Avoid prolonged skin contact with the concentrated material.

Foam Spray Decontaminant: A variety of foam spray decontamination products are available which are marketed as radioactive decontaminants. However, many other foam cleaning products accomplish decontamination just as effectively at a much lower cost; most of these are marketed in any store as bathroom or kitchen cleaning agents. Spray the foam on the contaminated areas, let sit for a few minutes then wipe off with a dry paper towel.

Other Decontaminating Agents: Many other agents will work to clean radioactive contamination that has been resistant to the above methods. Contact the RSO for assistance with difficulty in removing contamination. He/she will help identify a method of decontamination which will work for your surface, nuclide, chemical form, and location. Depending on these factors, effective solutions to the problem will be identified.

Contamination on Skin: Use lukewarm (not hot or cold) water and a mild cleaning agent, such as soap. Do not rub hard or scrub with abrasives, which may break the surface of the skin. Clean the affected area in a downwards fashion, with the grain of the skin and hair, not against it, and towards the tips of extremities, not upwards. Check the area after gently drying. If still contaminated, use a cream hand cleaner which contains no abrasives. Remember to notify the RSO immediately if personnel contamination occurs or is suspected. Also, note the readings of radioactive contamination detected with the survey instrument and the times that it was discovered and then removed.

C. Emergency Surgery of Patients Who Have Received Therapeutic Amounts of Radionuclides (this now includes therapeutic amounts of accelerator-produced radioactive materials or any discrete sources of radium-226)

The following procedures should be followed:

1. If emergency surgery is performed within the first 24 hours following the administration of I-131 sodium iodide, fluids (e.g., blood, urine) will be carefully removed and contained in a closed system.

2. Protective eye wear will be worn by the surgeon and any personnel involved in the surgical procedure for protection of the eyes from possible splashing of radioactive material and exposure from beta radiation (if applicable).

3. The radiation safety staff will direct personnel in methods to keep doses ALARA during surgical procedures.

4. If an injury occurs during surgery that results in a cut or tear in the glove used, the individual involved will be monitored to determine if radioactive material was introduced into the wound. The RSO will be informed of any possible radiation hazard.

D. Autopsy of Patients Who Have Received Therapeutic Amounts of Radionuclides (this now includes therapeutic amounts of accelerator-produced radioactive materials or any discrete sources of radium-226)

The following procedures should be followed:

1. Immediately notify the AU in charge of the patient and the RSO upon death of a therapy patient.

2. An autopsy will be performed only after consultation and permission from the RSO. Radiation safety staff should evaluate the radiation hazard(s), direct personnel in safety and protection, and suggest suitable procedures in order to keep doses ALARA during the autopsy.

3. Protective eye wear should be worn by the pathologist and assisting staff for protection from possible splashing of radioactive material. Consider the need for protection against exposure from high-energy beta rays in cases involving therapy with P-32 and Y-90.

4. Remove tissues containing large activities early to help reduce exposure of autopsy personnel. Shield and dispose of contaminated tissues in accord with license conditions. In some cases, exposure reduction may be accomplished by removing tissues for dissection to a location where the exposure rate is lower.

5. If an injury occurs during the autopsy that results in a cut or tear in the glove, monitor the wound and decontaminate as appropriate to the situation; inform radiation safety staff.

References: NRCP Report No. 111, "Developing Radiation Emergency Plans for Academic, Medical, and Industrial Facilities," 1991, contains helpful information. It is available from the National Council on Radiation Protection and Measurements, 7910 Woodmont Avenue, Suite 400, Bethesda, Maryland 20814-3095. NCRP's telephone numbers are: (301) 657-2652 , 1-800-229-2652.

C. *Fire*

1. Use the following emergency telephone numbers:

Fire Department:

a. For any fire involving serious injuries, call 7-911. Do not delay. Tell the dispatcher that radioactive material is involved.
b. Business hours, and after hours, call the Security Control Room on telephone (787) 758-2525, ext. 1000. The control room will call 7-911.
c. Business hours, call the Radiation Safety Office at (787) 758-2525, ext. 1687, 1688.
d. Business hours, call the Radiation Safety Office direct line (787) 766-3062.

2. Call the Radiation Safety Office.
3. Try to extinguish the fire without risking the safety of personnel.
4. Avoid spreading the contamination.
5. Do not continue work in the laboratory without Radiation Safety Office approval.

6. Again, call 7-911 without delay for any serious injuries. Give as much information as possible regarding the nature of the accident and the injuries that are present. Do not hang up the phone until you are instructed to do so.

D. Explosion

1. **For any accident involving serious injuries, first call 7-911. Do not delay.** Inform the dispatcher that the accident involves radioactive material.
2. Perform any lifesaving and first-aid measure that you can. There may be a significant amount of time before the Hazardous Material (HAZMAT) unit of the Emergency Medical System can get to the accident.
3. Use the following emergency telephone numbers:

Security Control Room of MSC

   a. Call the Security Control Room on telephone (787) 758-2525, ext. 1000.
   b. Call the Radiation Safety Office (787) 758-2525, ext. 1687 and 1688.
   c. Call the Occupational Health Clinic (787) 758-2525, ext. 2910, 2911, 2913.

4. Turn off all fume hoods and ventilation where possible.
5. If possible, evacuate the area of the explosion. Restrict contamination to the area by removing your gloves, shoes, and laboratory coats before leaving.
6. Wash all contaminated areas of skin thoroughly, without vigorous scrubbing, with cool water and mild soap for five to ten minutes. Do this as soon as possible after the accident.
7. Flush any superficial wound thoroughly with cool water and cover with a sterile dressing.
8. Remember also to remove all clothing that may have been contaminated.
9. Do not leave the area or go to the OHC until someone from the OHS has determined that you have been successfully decontaminated.

E. Accidents Involving Large Sources

1. If there is any reason to suspect that a large source such as the gamma-cell is unshielded or leaking in any way, you should immediately evacuate all personnel to a safe area.
2. Call the MSC Security Control Room on telephone (787) 758-2525, ext. 1000 and call Radiation Safety Office at telephone (787) 758-2525, ext. 1687 and 1688 or the direct line (787) 766-3062.

Reference

1. International Commission on Radiological Protection. The Principles and General Procedures for Handling Emergency and Accidental Exposure to Workers; Publication 28. Elmsford, New York: Pergaman Press, 1978.
2. U.S. Nuclear Regulatory Commission, Washington, D.C. Nuclear Regulatory Guides:
3. 8.7 Instructions for Recording and Reporting Occupational Radiation Exposure Data, 1992. (Draft DG-8007, Proposed Revision 1, published 11/1991).
4. 8.9 Acceptable Concepts, Models, Equations, and Assumptions for a Bioassay Program, 1993. (Draft DG-8009, Proposed Revision 1, published 12/1991).
5. 8.10 Operating Philosophy for Maintaining Occupational Radiation Exposures As Low As Reasonably Achievable, 1975. 1-R 5/1977.
6. 8.13 Instruction Concerning Prenatal Radiation Exposure, 1987. (Draft OH 015-4, Proposed Revision 2, published 8/1981) (Draft DG-8014, Proposed Revision 3, published 10/1994).
7. 8.20 Applications of Bioassay for I-125 and I-131, 1979.
8. 8.25 Air Sampling in the Workplace, 1992. (Draft OH 905-4 published 10/1979) (Draft DG-8003, Proposed Revision 1, published 9/1191).
9. 8.29 Instruction Concerning Risks from Occupational Radiation Exposure, 1996. (Draft OH 902-4 published 5/1980) (Draft DG-8012, Proposed Revision 1, published 12/1994).
10. 8.34 Monitoring Criterial and Methods to Calculate Occupational Radiation Doses, 1992. (Draft DG-8010 published 2/1991).
11. 8.35 Planned Special Exposures, 1992. (Draft DG-8008 published 12/1991).
12. 8.36 Radiation Dose to the Embryo/Fetus, 1992. (Draft DG-8011 published 2/1992).
13. 8.37 ALARA Levels for Effluents from Materials Facilities, 1993. (Draft DG-8013 published 10/1992) (draft DG-8016, Proposed Revision 1, published 12/1995).
14. 10.11 Guide for the preparation of applications for radiation safety evaluation and registration of sealed sources containing by-product material, 1987. (Draft FC 603-4 published 12/1986).
15. Appendix X Guidance on complying with new part 20 requirements, 1992.
16. Shapiro, J. Radiation Protection. 2nd ed. Cambridge, Massachusetts: Harvard Univ. Press, 1981.

Appendix

A. Radiation Protection Dose Standards:

Radiation Dose Limits to Adult Radiation Workers:

- 5,000 mrem (50 mSv) per year total effective dose equivalent to the whole body, no one organ of which may exceed 50,000 mrem (500 mSv) per year.
- 15,000 mrem (150 mSv) per year to the lens of the eye
- 50,000 mrem (500 mSv) per year to the skin or to any extremities (hands and forearms, or feet and ankles)

Radiation Dose Limits to Minor (under age 18) Radiation Workers:

- 500 mrem (5 mSv) per year total effective dose equivalent to the whole body, no one organ of which may exceed 5,000 mrem (50 mSv) per year.
- 1500 mrem (15 mSv) per year to the lens of the eye
- 5000 mrem (50 mSv) per year to the skin or to any extremities (hands and forearms, or feet and ankles)

Radiation Dose Limits to Members of the General Public:

- 100 mrem (1 mSv) per year total effective dose equivalent to the whole body
- 2 mrem (0.02 mSv) total effective dose equivalent to the whole body per hour
- 500 mrem (5 mSv) total effective dose equivalent to the fetus of a Declared Pregnant Woman per gestation

B. Radiation Safety Due Dates:

ACTIVITY	DATE DUE
RADIOISTOPE INVENTORY REPORT	Monthly
RADIATION SURVEY REPORT	Monthly
RADIATION BADGES DISTRIBUTED & COLLECTED	Monthly & Quarterly
RADIATION METER CALIBRATION	ONCE/YEAR
EACH RADIATION WORKER SHOULD FORWARD THE REPORT(S) THROUGH HIS/HER AUTHORIZED USER TO THE RADIATION SAFETY OFFICE	

C. Record Keeping:

The requirements for maintaining records such as: decommissioning records, surveys, including the type of information required. All licensees are required to maintain these records in an identified location until the site is released for unrestricted use. In the event that the licensed activities are transferred to another person or entity, these records shall be transferred to the new licensee prior to transfer of the licensed activities. The new licensee is responsible for maintaining these records until the license is terminated. When the license is terminated, these records shall be transferred to NRC.

Radiation Protection Program:

Implementation and audits – 3 years
Receipts of radioactive material – 3 years
Tranfer of radioactive material – 3 years
Misadministration – 5 years
Dosage records – 3 years
Refresher courses – 3 years

Surveys:

Surveys meters and calibrations – 3 years
Surveys and Wipe test – 3 years
Leak test – 3 years
Dosimetry reports – until license ends
Bioassay reports – until license ends
Air monitoring – until license ends
Effluents reports - until license ends
Waste disposal - until license ends
Individual monitoring records - until license ends
Important to decommissioning - Until the site is released for unrestricted use

D. Table of Unit Conversions:

TO CONVERT	INTO	MULTIPLY BY
atomic mass units	grams	1.66×10^{-24}
atomic mass units	mev	931.478
barns	sq cm	10^{-24}
becquerels	curies	2.7027×10^{-11}
becquerels	piocuries	27.027
calories	ergs	4.184×10^{7}
calories	joules	4.184
curies	becquerels	3.7×10^{10}
curies	dis/sec	3.7×10^{10}
curies	dis/min	2.22×10^{12}
curies	dpm	2.22×10^{12}
curies	millicuries	10^{3}
curies	microcuries	10^{6}
curies	picocuries	10^{12}
curies	kilocuries	10^{-3}
dis/min	millicuries	4.505×10^{-10}
dis/min	microcuries	4.505×10^{-7}
dis/sec	millicuries	2.703×10^{-8}
dis/sec	microcuries	2.703×10^{-5}
ergs	joules	10^{-7}
gallons (US liq)	liters	3.785
gallons (US H_2O 60F))	lbs of H_2O	8.3282
gallons	pints (liq)	8
grams	joules/cm	9.807×10^{-5}
grams	joules/meter (newtons)	9.807×10^{-3}
grams	kilograms	0.001
grams	miligrams	1,000
gram-calories	joules	4.186
grays	rads	100
hours	days	0.04167
hours	weeks	5.952×10^{-3}
inches	centimeters	2.540
Inches	meters	0.0254
inches	milimeters	25.40
kilocuries	curies	10^{3}

kilograms	grams	1,000
kilograms	joules/cm	.09807
kilograms	joules/meter (newtons)	9.807
kilograms	pounds (avdp)	2.205
kilograms/cu meter	grams/cu cm	0.001
liters	cu cm	1,000
liters	gallons (US liq)	0.2642
liters	pints (US liq)	2.113
liters	quarts (US liq)	1.057
mev	ergs	1.6×10^{-6}
microcuries	dis/sec	3.700×10^{4}
microcuries	picocuries	1×10^{6}
microcuries	dis/min	2.220×10^{6}
millicuries	dis/sec	3.700×10^{7}
millicuries	dis/min	2.220×10^{9}
milligrams	grams	0.001
milligrams/liter	parts/million	1
milliliters	liters	0.001
millimeters	centimeters	0.1
rads	J/kg	0.01
rads	ergs/g	100
rads	MeV/cm^3 of air (stp)	8.071×10^{4}
rads	MeV/g	6.242×10^{7}
rads	grays	10^{-2}
rems	sieverts	10^{-2}
roentgen	esu/cu cm (air)	1
roentgen	ion prs/cu cm (air)	2.083×10^{9}
roentgen	ion prs/gm (air)	1.61×10^{12}
roentgen	mev/cu cm (air)	6.77×10^{4}
roentgen	mev/gm (air)	5.24×10^{7}
roentgen	ergs/gm (air)	83.80
roentgen	cals/gm (air)	2.0×10^{-6}
sievert	rems	100

E. Information of Radioisotopes:

TRITIUM H^3

Radioactive half-life T 1/2: .....12.4 years
Principal emission: .....18.6 keV beta (maximum)
Monitoring for contamination: .....Swipes counted by liquid scintillation
Biological Monitoring: .....Urine samples
Annual Limit on Intake, ingestion or inhalation: .....1×10^9 Bq (27 mCi) (tritiated water)
Maximum range in air: .....6 mm
Shielding required: .....none

Special Considerations for Open Sources:

- Tritium, because of its low beta-energy, cannot be monitored directly and therefore special care is needed to keep the working environment clean and tidy. Regular monitoring by counting swipes is advisable in areas where this nuclide is used.
- Tritium can be absorbed through the skin. Volatile compounds containing tritium, tritiated water and tritium gas should be handled in a fume hood.
- External contamination, although not causing a radiation dose itself, should be kept as low as possible as it can lead to internal and hence hazardous contamination; it can also interfere in experimental results.
- DNA precursors (*eg tritiated thymidine*) are regarded as more toxic than tritiated water partly because activity is concentrated into cell nuclei. This is reflected by lower ALI's for the material in this form.
- Bioassays may be required for handling high amounts. Consult permit.

SULPHUR-35 S^{35}

Radioactive half-life T 1/2: .....87.4 days
Principal emission: .....0.167 MeV beta (maximum)
Monitoring for contamination: .....Swipes counted by liquid scintillation
Thin end-window Geiger-Müller detector
Biological Monitoring: .....Urine samples
Annual Limit on Intake (ALI) by inhalation or ingestion: .....2×10^8 Bq (5 mCi)
Maximum range in air: .....26 cm

Shielding:

- 1 cm Perspex/Plexiglas, Thinner Perspex/Plexiglas down to 3 mm, although adequate to reduce doses, does not have good mechanical properties. Glass containers, although not generally recommended for shielding of beta radiation, are effective for small quantities of S^{35}.

Special Considerations for Open Sources:

- Note that organic compounds are often strongly retained, and no limits of exposure have been set for them.
- Be careful not to generate sulphur dioxide or hydrogen sulphide which could be inhaled.
- Radiolysis of S^{35}-amino acids during storage and use may lead to the release of S^{35}-labelled volatile impurities. Handle such material in fume hood. Although the level of these impurities is small (typically less than 0.05%), contamination of the internal surfaces of storage and reaction vessels may occur. Vials should be opened and used in fume hoods.

CARBON 14 C^{14}

Radioactive half-life T 1/2: .....5730 years
Principal emission: .....0.156 MeV beta (maximum)
Monitoring for contamination: .....swipes counted by liquid scintillation
Thin end - window Geiger-Müller detector
Biological Monitoring: .....Urine samples, breath measurements (CO_2)
Annual Limit on Intake: .....4×10^7 Bq (1.1 mCi)

- by inhalation or ingestion

Maximum range in air: .....24 cm

Shielding:

- 1 cm Perspex/Plexiglas. Thinner Perspex/Plexiglas down to 3 mm, although adequate to reduce doses, does not have good mechanical properties. Glass containers, although not generally recommended for shielding of beta radiation, are effective for small quantities of 14 C.

Special Considerations for Open Sources:

- There is a possibility that some organic compounds can be absorbed through gloves.
- Care needs to be taken not to generate carbon dioxide which could be inhaled.
- Work with volatile compounds or those likely to generate carbon monoxide or carbon dioxide in fume hood.
- A mandatory wipe test for radioactive contamination after each use is require
- A dry run prior to the performance of unfamiliar procedures to preclude unexpected complications. In addition, the U.S. Nuclear Regulatory Commission (NRC) recommends that the radiation safety officer (RSO) be present during new procedures.

PHOSPHORUS 32 P^{32}

Radioactive half-life T 1/2: ……14.3 days
Principal emission: ……1.709 MeV beta (maximum)
Monitoring for contamination: ……swipes counted by liquid scintillation Geiger-Müller detector
Biological Monitoring: ……Urine samples
Annual Limit on Intake (ALI) by ingestion or inhalation: ……1×10^7 Bq (0.27 mCi)
Maximum range in air: ……790 cm
Dose rate from 1 MBq (27 m Ci) in 1 ml:

- 210 mSv/h (21 rem/h) at surface
- 2.5 *u*Sv/h (0.25 mrem/h) at 1 m

Shielding required: ……Plexiglas or similar plastic (at least one cm)

Special Considerations for Open Sources:

- Phosphorus-32 is the highest energy beta emitting radionuclide commonly encountered in research laboratories and as such requires special care. Avoid exposure as much as possible (*e.g. do not hold tubes containing even small quantities of 32 P any longer than necessary - use a stand or holder*).
- If quantities greater than a few tens of MBq (1 mCi) are used, wrist or ring dosimeters must be worn. Remember wrist dosimeters alone may fail to indicate high dose to the fingertips. The use of lead-impregnated rubber gloves is also recommended.
- Even with low-density materials (for example, Perspex/Plexiglas) the absorption of the beta-particles gives rise to relatively high energy Bremsstrahlung which may require some lead shielding when quantities greater than a few hundred MBq (or tens of millicuries) are being handled.

Specific Precautions for the Handling of Phosphorus-32:

- Solutions containing more than 1 mCi (37 MBq) of 32 P or carrier-free solutions of 32 P require specific handling precautions. Carrier-free material is readily absorbed by the skin and will contribute significant doses to the bone where it is preferentially deposited. Careful handling can avoid high radiation doses to the hands while working with this material.
- Follow all general radioisotope safety precautions
- Double glove (disposable), changing the outer pair frequently during the procedure
- Plexiglas shielding should be used as shielding for all 32 P handling and must be used with quantities more than 1 mCi (37 MBq). The half-value layer (HVL) thickness for 32 P is 1 cm of plexiglas. Lead or other high-density material may be used as secondary shielding
- Safety glasses or goggles should be used when handling 32 P. This will reduce the external irradiation of the eye and skin as well as prevent the high radiation doses which accompany accidental contamination by splashing
- Wrist or ring radiation dosimeters as well as whole body dosimeters must be worn if handling quantities of 1 mCi (37 MBq) or larger
- More than one person should be present during handling involving more than 1 mCi (37 MBq)
- Due to the high dose rates encountered, work should never be carried out above an open container of 32 P or other high energy beta emitter
- A solution of phosphate buffer is most effective in removing 32 P contaminations from surfaces.

IODINE-125 I^{125}

Radioactive half-life T 1/2: .....59.6 days
Principal Emissions:.....35 keV gamma (7% emitted, 93% internally converted)
27-32 keV X-rays (140% Te K X-rays)
Monitoring for contamination: .....swipes counted by liquid scintillation
Thin end-window Geiger-Müller detector
Biological Monitoring: .....Thyroid scans (scintillation detector NaI)
Annual Limit on Intake (ALI) by inhalation: .....2×10^6 Bq (0.055 m Ci)
Dose rate from 1 GBq point 41 mSv/h (4.1 mrem/h) source at 1 m: First half value layer: 0.02 mm lead

Special Considerations for Open Sources:

- Volatilization of iodine is the most significant problem with this isotope. Simply opening a vial of sodium (I^{125}) iodide at high radioactive concentration can cause minute droplets of up to 100 Bq to become airborne. Solutions containing iodide ions should not be made acidic or stored frozen: both lead to formation of volatile elemental iodine.
- As some iodo-compounds can penetrate surgical rubber gloves, it is advisable to wear two pairs, or polythene (polyethylene) gloves over rubber.
- In the event of suspected or actual significant contamination of personnel the thyroid should be blocked by administration of stable iodine as tablets of potassium iodate (170 mg) or potassium iodide (130 mg) which are available at hospitals.
- To render any spilled Iodine-125 chemically stable the area of the spill should be treated with alkaline sodium thiosulphate solution prior to commencing decontamination. Note, however, that the quantity of radioiodine in normal RIA kits (usually <3.7 MBq or 100 m Ci) is such that these can be handled safely with reasonable care on the open bench.

Specific Precautions for the Handling of Radioiodine:

- Follow all general radioisotope safety practices
- Users of radioiodine must participate in the thyroid bioassay program
- Background bioassay must be conducted prior to beginning use of radioiodine
- Bioassays of the thyroid must be performed within four days after radioiodine use
- Double glove (disposable), changing the outer pair frequently during the radioiodine procedure
- Ensure that the radioiodine container has been properly checked for leakage upon receipt
- Vials containing radioiodine should be opened only in a fume hood, and containers of radioiodine should be kept closed when not required
- Carry out all work involving volatile forms of radioiodine in a fume hood
- A properly functioning Vent Alert alarm system will warn users if the fume hood does not have a proper air exhaust in the range of 100-200 linear feet per minute. Contact the RPS if there is any doubt as to the proper operation of the fume hood
- Charcoal filtration of the exhaust may be required for large quantities of radioiodine
- Direct contact with unshielded containers of radioiodine should be avoided
- Shielding material of sheet lead will reduce doses received from external gamma radiation
- Minimizing the time near radioiodine sources will reduce doses from external radiation
- Radioactive waste contaminated with volatile radioiodine should be kept in the fume hood
- Shielding may be necessary to reduce radiation fields near the waste
- Radioiodine solutions with a pH of 8 or more are less likely to produce vapors
- During the experiment and afterwards, monitor the area with appropriate detection equipment.
- A solution consisting of 0.1 M sodium iodide, 0.1 M sodium hydroxide and 0.1 M sodium thiosulphate is effective in cleaning radioiodine spills.
- Wash hands immediately following a radioiodine procedure.

Contact the Radiation Safety Office immediately in case of any emergency situation involving radioiodine or other radioactive material.

IODINE-131 I^{131}

Radioactive half-life T 1/2: .....8.04 days
Principal Emissions: .....0.365 MeV gamma
0.638 MeV gamma
0.606 MeV beta (maximum)
0.334 MeV beta (maximum)
Monitoring for contamination: .....swipes counted by liquid scintillation detector (NaI)
Biological Monitoring: .....Thyroid scans (NaI scintillation detector)
Annual Limit on Intake (ALI) by inhalation: .....1×10^{6} Bq (0.027 mCi)
Dose rate from 1 GBq point 76.5 mSv/h (7.65 mrem/h) source at 1 m: First half value layer: 0.50 cm lead

Special Considerations for Open Sources:

- Volatilization of iodine is the most significant problem with this isotope. Simply opening a vial of sodium (I^{131}) iodide at high radioactive concentration can cause minute droplets to become airborne. Solutions containing iodide ions should not be made acidic or stored frozen: both lead to formation of volatile elemental iodine.
- As some iodine-compounds can penetrate surgical rubber gloves, it is advisable to wear two pairs or polythene (polyethylene) gloves over rubber.
- In the event of suspected or actual significant contamination of personnel, the thyroid may be blocked by administration of stable iodine as tablets of potassium iodate (170 mg) or potassium iodide (130 mg) which are available at hospitals.
- To render any spilled Iodine-131 chemically stable the area of the spill should be treated with alkaline sodium thiosulphate solution before commencing decontamination.

Specific Precautions for the Handling of Radioiodine:

- Follow all general radioisotope safety practices
- Users of radioiodine must participate in the thyroid bioassay program
- Background bioassay must be conducted prior to beginning use of radioiodine
- Bioassays of the thyroid must be performed within four days after radioiodine use
- Contact the *Radiation Safety Office f*or information on this service
- Double glove (disposable), changing the outer pair frequently during the radioiodine procedure
- Ensure that the radioiodine container has been properly checked for leakage upon receipt
- Vials containing radioiodine should be opened only in a fume hood, and containers of radioiodine should be kept closed when not required
- Carry out all work involving volatile forms of radioiodine in a fume hood
- A properly functioning Vent Alert alarm system will warn users if the fume hood does not have a proper air exhaust in the range of 100-200 linear feet per minute.
- Charcoal filtration of the exhaust may be required for large quantities of radioiodine
- Direct contact with unshielded containers of radioiodine should be avoided
- Shielding material of sheet lead will reduce doses received from external gamma radiation
- Minimizing the time near radioiodine sources will reduce doses from external radiation
- Radioactive waste contaminated with volatile radioiodine should be kept in the fume hood
- Shielding may be necessary to reduce radiation fields near the waste
- Radioiodine solutions with a pH of 8 or more are less likely to produce vapors
- During the experiment and afterwards, monitor the area with appropriate detection equipment.
- A solution consisting of 0.1 M sodium iodide, 0.1 M sodium hydroxide and 0.1 M sodium thiosulphate is effective in cleaning radioiodine spills.
- Wash hands immediately following a radioiodine procedure.

Contact the Radiation Safety Office immediately in case of any emergency situation involving radioiodine or other radioactive material.

FLUORODEOXYGLUCOSE-F18

Radioactive half-life T 1/2: ..... 109.7 minutes.
Principal Emissions: ..... 511.0 keV gamma
249.8 keV positron
Monitoring for contamination: .....swipes counted by wipe test counter

External Radiation
The specific gamma ray constant for fluorine F 18 is 6.0 R/hr/mCi (0.3 Gy/hr/kB) at 1cm. The half-value layer (HVL) for the 511 keV photons is 4.1 mm lead (Pb). A range of values for the attenuation of radiation results from the interposition of various thickness of Pb. The range of attenuation coefficients for this radionuclide is shown in Table 2. For example, the interposition of an 8.3 mm thickness of Pb, with a coefficient of attenuation of 0.25, will decrease the external radiation by 75%.

Special Considerations for Open Sources:

- Handling time should be kept to a minimum and appropriate
- Shielding should be used such as syringe shields and tongs.
- It is advisable to wear two pairs or polythene (polyethylene) gloves over rubber.
- Store at room temperature.
- Storage and disposal of products should be controlled in a manner, which is in compliance with appropriate regulations of federal or state government agency authorized to license the use of this radionuclide.
- Contain and collect spillage and place in container for disposal according to local regulations. Handle waste materials, including gloves, protective clothing, contaminated spill cleanup material, etc. as appropriate for chemically and pharmacologically similar materials.

Specific Precautions for the Handling of Radioiodine:

- Follow all general radioisotope safety practices
- Contact the *Radiation Safety Office* for information on this service
- Double glove (disposable), changing the outer pair frequently during the dosage preparation and administration.
- A laboratory coat must be worn when handling this product.
- Not expected to require personal respirator usage.
- Glasses or goggles are recommended if eye contact is possible.
- Ensure that the radioisotope container has been properly checked for leakage upon receipt
- Direct contact with unshielded containers should be avoided
- Shielding material of sheet lead will reduce doses received from external gamma radiation
- Minimizing the time near F-18 sources will reduce doses from external radiation
- Radioactive waste contaminated with F-18 should be kept in lead waste container for decay
- Shielding may be necessary to reduce radiation fields near the waste
- Monitor the area with appropriate detection equipment before leaving the laboratory on daily basis or when necessary.
- Wash hands immediately following a F-18 procedure before breaks and immediately after handling the product.
- If skin contact occurs, wash the affected area thoroughly with soap and water until no more radioactivity can be removed. Always blot dry. Do not abrade skin. Notify the Radiation Safety Officer
- Prevent release to drains and waterways. Prevent release to the environment.
- Properly sealed containers are not expected to require and special ventilation.

Contact the Radiation Safety Office immediately in case of any emergency situation involving radioiodine or other radioactive material.

Glossary

Absorbed dose: is the energy imparted by ionizing radiation per unit mass of irradiated material. The units of absorbed dose are the rad and the gray (Gy).

Activity: is the rate of disintegration (transformation) or decay of radioactive material. The units of activity are the curie (Ci) and the becquerel (Bq).

Alpha particle: is a strongly ionizing particle emitted from the nucleus of an atom during radioactive decay, containing 2 protons and neutrons and having a double positive charge.

Alternate Authorized User: serves in the absence of the Authorized user and can assume any duties as assigned.

Authorized User: an employee who is approved by the RSO and RSC and is ultimately responsible for the safety of those who use radioisotopes. This under his or her supervision.

Beta particle: is an ionizing charge particle emitted from the nucleus of an atom during radioactive decay, equal in mass and charge to an electron.

Bioassay: determination of type, quantity, concentration, and, in some cases, the location of radioactive material in the human body, by direct measurement (in vivo counting) or by evaluation of materials from the human body.

Biological half-life: is the length of time required for one-half of a radioactive substance to be biologically eliminated from the body.

Bremsstrahlung: is electromagnetic (x-ray) radiation associated with the deceleration of charged particles passing through matter.

Contamination: is the deposition of radioactive material in any place where it is not wanted.

Controlled area: means an area, outside of a restricted area but inside the site boundary, access to which can be limited by the licensee for any reason.

Counts per minute (cpm): is the number of nuclear transformations from radioactive decay that are detected by a counting instrument in one minute.

Curie (Ci): is a unit of activity equal to 37 billion disintegrations per second.

Declared pregnant woman: means a woman who has voluntarily informed her employer, in writing, of her pregnancy and the estimated date of conception.

Disintegrations per minute (dpm): is the number of nuclear transformations from radioactive decay in one minute.

Dose equivalent: quantity of radiation dose on a common scale used to calculate the effective absorbed dose. The units of dose equivalent are the rem and sievert (Sv).

Dosimeter: is a device used to determine the external radiation dose a person has received.

Effective half life: is the length of time required for a radioactive substance in the body to lose one-half of its activity (by biological elimination and radioactive decay).

Exposure: means the amount of ionization in air from x-rays and gamma rays.

Extremity: means hand, elbow, arm below the elbow, foot, knee, or leg below the knee.

Gamma rays: are very penetrating electromagnetic radiations emitted from a nucleus of an atom during radioactive decay.

Half-life: is the length of time required for a radioactive substance to lose one-half of its activity by radioactive decay.

Limits (dose limits): means the permissible upper bounds of radiation doses.

Permitted worker: is a laboratory worker who does not work with radioactive materials but works in a radiation laboratory.

Photon: means a type of radiation in the form of an electromagnetic wave.

Rad: is a unit of radiation absorbed dose. One rad is equal to 100 ergs per gram.

Radioactive decay: is the spontaneous process of unstable nuclei in an atom disintegrating into stable nuclei, releasing radiation in the process.

Radiation (ionizing radiation): means particles capable of producing ions, alpha particles, beta particles, gamma rays, x-rays, neutrons, high-speed electrons, high-speed protons, and other.

Radiation Workers: are those personnel listed on the Authorized User Form of the supervisor to conduct work with radioactive materials.

Radioisotope: is a radioactive nuclide of a particular element.

Rem: is a unit of dose equivalent. One rem is approximately equal to one rad of beta, gamma, or x-ray radiation, or 1/20 of alpha radiation.

Restricted area: means an area, where access to which is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials.

Roentgen: is a unit of radiation exposure. One roentgen is equal to 0.00025 Coulombs of electrical charge per kilogram of air.

Thermoluminescent Dosimeter (TLD): is a dosimeter worn by radiation workers to measure their radiation dose. The TLD contains crystalline material which stores a fraction of the absorbed ionizing radiation and releases this energy in the form of light photons when heated.

Total Effective Dose Equivalent (TEDE): means the sum of the deep-dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).

Unrestricted area: means an area, where access to which is neither limited nor controlled by the licensee.

X-rays: is a penetrating type of photon radiation emitted from outside the nucleus of a target atom during bombardment of a metal with fast electrons.

This Manual was adapted from the Radiation Safety Manual prepared by the Center for Disease Control (CDC) in Atlanta available on the internet.

Forms

MEMORANDUM

Date

Memo to: Chief of Security

From: Radiation Safety Officer

Subject: Receipt of Packages Containing Radioactive Material

The security guard on duty shall accept delivery of packages containing radioactive material that arrive during other than normal working hours. Packages should be placed on a cart or wheelchair and taken immediately to the storage area that is in the Nuclear Medicine Department. Unlock the door, place the package on the floor, and relock the door.

If the package appears to be damaged, immediately contact one of the individuals identified below. Ask the carrier to remain at the facility until it can be determined that neither the driver nor the delivery vehicle is contaminated.

If you have any questions concerning this memorandum, please call our Radiation Safety Officer: _____ at _____.

Radiation Safety Office: _____ extension number _____

Chairperson of the RSC: _____ at _____

APPLICATION FOR THE USE OF RADIOACTIVE MATERIAL NUCLEAR MEDICINE DEPARTMENT

Revised June 14, 2021

1. Submit original and two copies to the Radiation Safety Office.
2. Each approved application is valid for one year.
3. The Authorized User (AU) is required to submit renewal 30 days before the expiration date of current license.

1. Name of Chief Department:

2. Department and Lab Number:

3. Telephone and extension number:

4. E-mail address of the Authorize User:

Please indicate:

New Application: _____
Renewal Application: _____
If any changes occurred, detail in item #14

5 List training and previous experience of Chief Department in the handling of radioactive material.

6. Title of research proposal	7. Funding Source(s)

8. List personnel to be handling radioactive material under Authorize User's supervision and date of training. Please include residents and students under the Nuclear Medicine Technologist Program.	9. ☐ MSC Employee / Job title

Radioisotopes for clinical use (therapeutic and diagnostic) and Possession limit of isotope requested (specific amount per isotope in mCi or uCi):

10. Isotopes	*11. Amount*	*12. Commercial Vendor*
☐ Tc^{99M} (Sodium Pertechnetate)		
☐ Ga^{67} (Gallium Cytrate)		
☐ Tl^{201} (Thallium Chloride)		
☐ I^{131} (Iodine 131)		
☐ I^{123} (Iodine 123)		
☐ I^{125} (Iodine 125)		
☐ In^{111} (Pentatate Indium Disodium)		
☐ Sr^{89} (Strontium 89 Chloride)		
☐ Sm^{153} (Samarium 153 EDTMP)		
☐ C^{14} (Carbon 14)		
☐ P^{32} (Phophurous 32)		
☐ R^{223} (Radium 223)		
☐ Co^{57} (Cobalt 57)		
☐ Cs^{137} (Cesium 137)		
☐ Ba^{133} (Barium 133)		
☐ F^{18} (Fluorine 18)		

13. Other Potential Hazards:

14. For Renewal Applications. Please indicate if there has been any changes in the following areas:

Any changes in the following areas?	Yes	No	If yes, please detail
Radioisotope:	☐	☐	
Protocol(s):	☐	☐	
Personnel:	☐	☐	
New equipment:	☐	☐	
Decommission equipment:	☐	☐	
Facility or reorganization:	☐	☐	

15. Description of protocols used for Nuclear Medicine and experimental procedures with radioactive material. Nuclear Medicine Clinical Protocols are available upon request in the Nuclear Medicine Procedures Manual: ☐ Yes or ☐ No

16. Will the project or procedure involve administration of radioactive material?

To animals: ☐ Yes ☐ No

To humans: ☐ Yes ☐ No

17. Description of safety procedures while handling radioactive material:
May use additional pages if necessary.

18. Radiation Survey Instruments available in the immediate area:

a. Radiation Survey Instruments b. Radioactivity Instruments

Radiation Survey Instruments	Geiger Counter Instrument		Geiger Counter Instrument		Well Counter Instrument
	Instrument	Probe	Instrument	Probe	
Manufacturer:					
Model:					
Series Number:					

19. Signature of Chief Department: _____ Date: _____

20. Print Name: _____ Signature of user: _____
Print Name: _____ Signature of user: _____
Print Name: _____ Signature of user: _____
Print Name: _____ Signature of user: _____
Print Name: _____ Signature of user: _____
Print Name: _____ Signature of user: _____

FOR THE USE OF THE RADIATION SAFETY COMMITTE

21. Signature of RSC President: _____ Approved Date: _____

22. Signature of RSO: _____ Approved Date: _____

23. Expiration date: _____

Note: The clinical user must present evidence of Radiation Safety Training for all personnel to be handling radioactive material. Remember, all personnel must take an annual refresher course. For further information, please contact us at phone number (787) 758-2525 ext. 1687 or 1688.

INSTRUCTIONS ON COMPLETING APPLICATION FOR THE USE OF RADIOACTIVE MATERIAL FOR NUCLEAR MEDICINE LABORATORY (Revised June 15, 2018)

This form can be found at the following website (http://committees.rcm.upr.edu/radiation.html)

Eligibility: Only faculty members are allowed to apply for a radioisotope license. Students and laboratory technicians may use radioisotopes under the supervision of a licensed authorized user. By signing this application the authorized user is agreeing that byproduct material will be used only by, or under the direct supervision of, individuals who have at least 40 hours of training and have experience in the safe handling of radioactive materials.

New users: Please indicate if you are applying for the first time. You are required to present evidence of adequate training in radiation protection and experience handling the types and quantities of licensed material that is propose to use. It is required to take the Radiation Safety Training offered by the Office of Laboratory Safety in Research and the annual refresher course.

Renewals: If you are renewing your license, indicate if there have been any changes and provide details on item 14. It is required to take the annual Radiation Safety refresher course offered by the Office of Laboratory Safety in Research.

All applicants should submit two copies of the application and documents to the Radiation Safety Office 30 days before the expiration date of the current license. Qualified individuals of the UPR- Medical Sciences Campus as authorized by the Radiation Safety Committee and engaged as principal investigators and/or have significant responsibility for administrative, medical, academic or experimental functions involving radioisotopes and can demonstrate an acceptable level of confidence in the safe handling of radioactive materials. Approved application is valid only for the authorize user, requested radioisotope, location and equipment. New applicants for the use of radioactive materials should submit an application to the Radiation Safety Office for the RSC evaluation and approval. Please indicate if you are applying for the first time (New Application) or if you are renewing the application (Renewal Application).

1. Name of applicant performing immediate supervision of laboratory operations.

2. Write the department and the laboratory number were radioisotopes are going to be handled.

3. Write the laboratory telephone and the extension number.

4. Write the principal investigator's e-mail address.

5. Applicant must submit a statement that byproduct material will be used only by, or under the direct supervision of, individuals who have received: at least 40 hours of training and experience in the safe handling of radioactive materials, and in the characteristics of ionizing dose and quantities, radiation detection instrumentation, and biological hazards of exposure to radiation appropriate to the type and forms of byproduct material to be used (20 CFR 33.15 (b) (2)).

   Write a brief description of direct laboratory experience with radioisotopes, university where they were used, type of protocol (e.g., in vivo, in vitro). Include the dates of any radiation safety trainings in the use, management and disposal of radioisotopes. List radioisotope courses, where and when taken.

6. Write the title(s) of the experiment(s) proposal(s).

7. Indicate funding sources for the investigational proposal.

8. List all technical personnel, residents and students of who will be handling radioisotopes. Give a brief description of radioisotope experience of individuals using the produced radioisotope under applicant's supervision. Include the Radiation Safety training certificate from the MSC. This personnel list should be periodically updated. You may use additional pages if required.

   Note: Only individuals Scientists, Program Directors, and/or investigators at staff positions may be authorized by the Radiation Safety Committee to use radioactive materials in research activities at the UPR-Medical Sciences Campus. Candidates should submit evidence of training and experience in accordance with the requirements of 20 CFR 33.15 (b) (2).
   Research activities, ancillary personnel and radiation workers must receive instructions as specified in 10 CFR-19.12. The Radiation Safety Committee and RSO will make certain that the authorized user and personnel supervisor certifies that all laboratory personnel will be properly instructed before assuming duties and whenever there is a significant change in duties, regulations, or the terms of the Institutional License.

9. Please indicate if the technical personnel and students are MSC employees. Clarify their position.

   Note: It is required to present a copy of the MSC employee's identification card and MSC students ID.

10. Indicate with an (X) the radioisotope to be used.

11. The NRC license states precisely the quantity of each radioisotope that is permitted on the MSC at any one time. Amendments are possible, but must be justified.

    You should also indicate the amount of radioactive material stored in your laboratory freezer in millicuries (mCi) or microcurie (uCi). Also indicate the amount of radioactive waste generated in your laboratory in millicuries (mCi) or micro curie (uCi).

    Please note that the quantities requested must have the correct activity unit in terms of mille-curies (mCi) or micro- curies (uCi). Requests for very large quantities of radioisotope should be fully justified on a continuation page. Failure to supply this information correctly is the most common reason that applications are returned to the originator for clarification.

12. Provide the name of the company from which radioactive material will be purchased. New suppliers may request from you a copy of the MSC-NRC license. (Consult the RSO).

13. Is radioisotope a gamma or hard beta emitter? Is radioactive gas generated? Other hazards?

14. If you are renewing your application indicate any changes in the following areas, please detail:
    - Radioisotope(s)
    - Protocol(s)
    - Personnel
    - New equipment
    - Decommission equipment
    - Facility or reorganization

15. Investigators or directors of research protocols involving the use of radioactive materials "in vitro" or animals will also have to provide the information requested in this form and fulfill the minimum experience and training. Applicant will submit a complete protocol describing his research plan to include its rationale, background, methods and a description of measures employed to minimize radiation exposure to the experimenter, any human subjects and the protection of the environment.

16. Indicate if experiment will involve humans or animals.

Before allowing an individual to care for animals used in studies with licensed material, the Radiation Safety Officer (RSO), Authorized User (AU), and/or veterinarian must ensure that he or she has sufficient training and experience to maintain doses ALARA, control contamination, handle waste appropriately, etc.

Classroom training may be in the form of lecture, video tape, or self-study and should cover the following subject areas:

- Principles and practices of radiation protection.
- Radioactivity measurements, monitoring techniques, and instrument usage.
- Mathematics and calculations basic to using and measuring radioactivity.
- Biological effects of radiation.

Appropriate on-the-job-training should consist of:

- Observing authorized personnel using survey equipment, using proper contamination control techniques, and proper disposal of radioactive material
- Using survey equipment, proper contamination control techniques, and proper disposal of radioactive material procedures under the supervision of, and in the physical presence of, an individual authorized to handle animals treated with licensed material or otherwise containing licensed material.

Note: It is also required by the Radiation Safety Committee to present a copy of the experiment proposal for evaluation of the applicant request.

17. Present a brief description of safety procedures in the use, management and disposal of radioactive material. Indicate clearly how the radioisotope will be used (in vitro, in vivo, etc.,), what quantities will be utilized per experiment, what potential hazards (if any) are present in the experimental protocol, in which room and in which part of the room (table-top, hood, etc.) will the radioisotope be handled, describe the procedure used for receiving radioactive materials in your laboratory, describe the survey contamination methods used in your laboratory after each experiment, indicate the survey instruments used for this purpose, what type of radioactive waste will be generated and how will they be disposed. How are you going to handle the radiation exposure of the personnel under the principal investigator's supervision. (Consult the RSO for assistance, if necessary). May use additional pages if required.

18. List instruments available; the following information must be included: manufacturer, model and series number for:

a. radiation survey for leak and/or contamination, (Geiger counters GM) not instruments for analysis such as liquid scintillation counters or gamma counters.
b. radioactivity measurements for analysis such as liquid scintillation counters or gamma counters.

19 The chief department signature and date submitted.
20 Write the names of all personnel handling radioactive material under the Authorize User or the Principal Investigator supervision. All personnel to be handling radioactive material must read and sign the application.
21 The signature of Chairperson of the Radiation Safety Committee and date approved.
22 The signature of Radiation Safety Officer and date approved.
23 Expiration date.

APPLICATION FOR THE USE OF RADIOACTIVE MATERIAL BIOMEDICAL RESEARCH

HPO-FORM 001(a)) Revised June 14, 2021

1. Submit original and two copies to the Radiation Safety Office.
2. Each approved application is valid only for the user, request radioisotope, location and for one year.
3. The AU user is required to submit a renewal application 30 days before expiration date of current license.
4. New applicants should submit an application form and should comply with all the requirements of the RSC/RSO

1. Name of Principal Investigator:

2. Department and Lab Number:

3. Telephone and extension number:

4. E-mail of Principal Investigator:

Please indicate:
New Application: _____
Renewal Application: _____
If any changes, please detail in item # 17

5. Brief past experience and training of above named individual in the use of radioisotopes

6. Title of experiment proposal	7. Funding Source(s)

8. Name of Authorized Personnel Handling Radioisotopes under applicant supervision.	9. ☐ Undergraduate ☐ Graduate student ID number required	10. ☐ MSC Employee Position required

11. Brief past experience and dates of radiation safety training of authorized personnel handling radioisotopes under applicant supervision.

12. Radioisotope(s) requested: ☐ ^{14}C ☐ ^{3}H ☐ ^{32}P ☐ ^{35}S ☐ ^{125}I ☐ ^{99M}Tc

13. Name(s) of radioactive compound(s) (Physical and Chemical forms):

14. Maximum amount that licensee may order per fiscal year under this license (specific amount per radioisotope in mCi or uCi):

Activity limits (amount / isotope mCi or uCi)	☐ ^{14}C	☐ ^{3}H	☐ ^{32}P	☐ ^{35}S	☐ ^{125}I	☐ ^{99M}Tc
Amount requested per year:						
Renewals: Indicate current amount in freezer:						
Renewals: Indicate current amount of waste:						
Amount approved by RSC / isotope:						

Reporting Small Quantity Protocol Radioactive Material Balance in grams:

Radioactive Material	Amount Received (Grams)	Date Received	Amount Removed (Grams)	Date Removed	Amount Remains (Grams)	Date Reported	Amount Radioactive Waste
Uranyl Acetate							
Uranyl Nitrate							
Uranyl Formate							
Uranyl Oxalate							
Magnesium Uranyl Acetate,							
Other							

15. Other Potential Hazards:
16. Name and address of commercial vendor:
17. For Renewal Applications. Please indicated if there have been any changes in the following areas:

Any changes in the following areas?	Yes	No	If yes, please detail
Radioisotope:			
Protocol(s):			
Personnel:			
New Equipment:			
Decommission Equipment			
Facility, reorganization:			
New Small Quantity Protocol Radioactive Material			

18. Description of experimental procedure with radioactive material:

19. Will the project involve administration of radioactive material?

To animals: ☐ Yes ☐ No

To humans: ☐ Yes ☐ No

For Electronic Microscopy ☐ Yes ☐ No

20. Description of safety procedures while handling radioactive material:
May use additional pages if necessary

21. Instruments available in the immediate area:

	a. Radiation Survey Instruments		b. Radioactivity Instruments
Survey Instruments	☐ Geiger Counter Instrument (GM)		☐ Liquid Scintillation Counter
	Instrument	Probe	
Manufacturer:			
Model:			
Series Number:			

22. Signature of Principal Investigator: _____ Date: _____

23. Signature of users under AU supervision:

Print Name: _____ Signature: _____
Print Name: _____ Signature: _____
Print Name: _____ Signature: _____
Print Name: _____ Signature: _____
Print Name: _____ Signature: _____
Print Name: _____ Signature: _____

FOR THE USE OF THE RADIATION SAFETY COMMITTE

24. Radiation Safety Committee amount approved / isotope:

☐ ^{14}C	☐ ^{3}H	☐ ^{32}P	☐ ^{35}S	☐ ^{125}I	☐ ^{99M}Tc

Radioactive Material	Amount Approved (Grams)
Uranyl Acetate	
Uranyl Nitrate	
Uranyl Formate	
Uranyl Oxalate	
Magnesium Uranyl Acetate,	
Other	

25. Signature of RSC President: _____ Approved Date: _____

26. Signature of RSO: _____ Approved Date: _____

27. Expiration date: _____

Note: The principal investigator must present evidence of Radiation Safety Training of all personnel handling radioisotopes before summiting this application. Also they are required to take the Radiation Safety Training offered by the Office of Laboratory Safety in Research before beginning with their duties and an annual refresher course. For further information, please contact us at phone number (787) 758-2525 ext. 1687, 1688.

INSTRUCTIONS FOR APPLICATION OF RADIOISOTOPE PRINCIPAL INVESTIGATOR (HPO-FORM 001(a))

The HPO-Form 001(a) must be completed online, website (http://committees.rcm.upr.edu).

Eligibility: Only faculty members are allowed to apply for a radioisotope license. Students and laboratory technicians may use radioisotopes under the supervision of a licensed authorized user. By signing this application, the authorized user is agreeing that byproduct material will be used only by, or under the direct supervision of, individuals who have at least 40 hours of training and have experience in the safe handling of radioactive materials.

New users: Please indicate if you are applying for the first time. You are require to present evidence of adequate training in radiation protection and experience handling the types and quantities of licensed material that is propose to use. Also need to take the Radiation Safety Training offered by the Office of Laboratory Safety in Research and there after an annual refresher course

Renewals: If you are renewing your license, please indicate if there have been any changes and provide detail of changes on item 17. You and your lab personnel are require to take the Radiation Protection refresher course.

All applicants should submit two copies of the application and documents to the Radiation Protection Office (RPO) in 30 days before expiration date of the current license. Qualified individuals of the UPR- Medical Sciences Campus as authorized by the Radiation Safety Committee and engaged as principal investigators and/or have significant responsibility for administrative, medical, academic or experimental functions involving radioisotopes and can demonstrate an acceptable level of confidence in the safe handling of radioactive materials. Approved application is valid only for the authorize user, request radioisotope, location and equipment. New applicants for the use of radioactive materials should submit an application to the Radiation Protection Office for the RSC evaluation and approval. Please indicate if you are applying for the first time (New Application) or if you are renewing the application (Renewal Application). If you are renewing your application and there has been any changes, please detail it on item 17.

1. Name of applicant performing immediate supervision of laboratory operations.

2. Write the department and the laboratories number were radioisotopes are going to be handled.

3. Write the laboratories telephone and the extension number.

4. Write the principal investigator's e-mail address.

5. Applicant must submit a statement that byproduct material will be used only by, or under the direct supervision of, individuals who have received: at least 40 hours of training and experience in the safe handling of radioactive materials, and in the characteristics of ionizing dose and quantities, radiation detection instrumentation, and biological hazards of exposure to radiation appropriate to the type and forms of byproduct material to be used (20 CFR 33.15 (b) (2)).

   Write a brief description of direct laboratory experience with radioisotopes university where used, type of protocol (e.g., in vivo, in vitro). Include the dates of any radiation safety

trainings in the use, management and disposal of radioisotopes. List radioisotope courses, where and when taken.

6. Write the title(s) of the experiment(s) proposal(s).

7. Indicate funding sources for the investigational proposal.

8. List all technical personnel and students who will be handling radioisotopes. Give a brief description of radioisotope experience of individuals using the produced radioisotope under applicant's supervision. Indicate if hold certificate from MSC training course. This personnel list should be periodically up-dated.
Note: Only individuals Scientists, Program Directors, and/or investigators at staff positions may be authorized by the Radiation Safety Committee to use radioactive materials in research activities at the UPR-Medical Sciences Campus. Candidates should submit evidence of training and experience in accordance with the requirements of 20 CFR 33.15 (b) (2).

   Research activities, ancillary personnel and radiation workers must receive instruction as specified in 10 CFR-19.12. Then the radiation Safety Committee and RSO should provide that the authorized user and personnel supervisor verify that all laboratory personnel will be properly instructed before assuming duties and whenever there is a significant change in duties, regulations, or the terms of the Institutional License.

   It is required to present copies of certificates of training to courses with the application.

9. Indicate status of undergraduate or graduate students. Please write the students identification number.

10. Please indicate if the technical personnel and students are MSC employee. Write their position.

    Note: It is required to present a copy of the MSC employee's identification card and MSC students ID.

11. Write a brief past experience and dates of radiation safety training of authorized personnel handling radioactive materials under applicant's supervision. New candidates should submit evidence of training and experience in accordance with the requirements of 10 CFR 33.15 (b) (2) that justify the safety of handling radioactive material.

12. Indicate with an (X) the radioisotope to be used.

13. Please indicate the radioactive compound(s) including physical and chemical forms (i.e 1251 estradiol; 35S enkephalin).

14. The NRC license states precisely the quantity of each radioisotope that is permitted on the MSC at any one time. Amendments are possible, but must be justified. Consider your experimental protocol and answer the questions carefully. What is the maximum to be used in a single experiment? How much will be ordered in a single shipment? How much will be ordered per fiscal year? When selecting limits, take into consideration the price and size of the commercially available material of interest.

You should also indicate the amount of radioactive material stored in your laboratory freezer in millicuries (mCi) or microcurie (uCi). Also indicate the amount of radioactive waste generated in your laboratory in millicuries (mCi) or microcurie (uCi).

Please note that the quantities requested must have the correct activity unit in terms of milli-curies (mCi) or micro- curies (uCi). Requests for very large quantities of radioisotope should be fully justified on a continuation page. Failure to supply this information correctly is the most common reason that applications are returned to the originator for clarification.

15. Is radioisotope a gamma or hard beta emitter? Is radioactive gas generated? Other hazard?

16. Company from which radioactive material will be purchased. New suppliers may request from you a copy of the MSC-NRC license. (Consult the RSO).

17. If you are renewing your application indicate any changes in the following areas please detail:
    - Radioisotope(s)
    - Protocol(s)
    - Personnel
    - New equipment
    - Decommission Equipment
    - Facility or reorganization

18. Investigators or directors of research protocols involving the use of radioactive materials "in vitro" or animals will also have to provide the information requested in this form and fulfill the minimum experience and training. Applicant will submit a complete protocol describing his research plan to include its rationale, background, methods and a description of measures employed to minimize radiation exposure to the experimenter, any human subjects and the protection of the environment.

19. Indicate if experiment will involve humans or animals.

Before allowing an individual to care for animals used in studies with or treated with licensed material, the Radiation Safety Officer (RSO), Authorized User (AU), and/or veterinarian must ensure that he or she has sufficient training and experience to maintain doses ALARA, control contamination, handle waste appropriately, etc.
Classroom training may be in the form of lecture, video tape, or self-study and should cover the following subject areas:

- Principles and practices of radiation protection
- Radioactivity measurements, monitoring techniques, and using instruments
- Mathematics and calculations basic to using and measuring radioactivity
- Biological effects of radiation.

Appropriate on-the-job-training should consist of:
- Observing authorized personnel using survey equipment, using proper contamination control techniques, and proper disposal of radioactive material

- Using survey equipment, proper contamination control techniques, and proper disposal of radioactive material procedures under the supervision of, and in the physical presence of, an individual authorized to handle animals treated with licensed material or otherwise containing licensed material.

Note: It is also required by the Radiation Safety Committee to present a copy(s) of the experiment(s) proposal(s) for evaluation of the applicant request.

20. Present a brief description of safety procedures in the use, management and disposal of radioactive material. Indicate clearly how the radioisotope will be used (in vitro, in vivo, etc.,), what quantities will be utilized per experiment, what potential hazards (if any) are present in the experimental protocol, in which room and in which part of the room (table-top, hood, etc.) will the radioisotope be used. Also describe the procedure used for receiving and opening of radioactive materials packages in your laboratory, describe the survey contamination methods used in your laboratory after each experiment, indicate the survey instruments used for this purpose, what types of radioactive waste will be generated and how will they be disposed. How are you going to handle the radiation exposure of the personnel under the principal investigators supervision. (Consult the RSO for assistance, if necessary).

21. List instruments available and the following information must be included: manufacturer, model and series number for:

    a. radiation survey for leak and/or contamination, (Geiger counters GM) not instruments for analysis such as liquid scintillation counters or gamma counters.
    b. radioactivity measurements for analysis such as liquid scintillation counters or gamma counters.

22. The principal investigators signature and date submitted.

23. Write the names of all personnel handling radioactive material under the Authorize User or the Principal Investigator supervision.

    Note: All personnel to be handling radioactive material must read and sign the application.

24. Radiation Safety Committee amount approved / isotope

25. The signature of Chairperson of the Radiation Safety Committee and date approved.

26. The signature of Radiation Safety Officer and date approved.

27. Expiration date

University of Puerto Rico
Medical Science Campus
Receipt of Radioactive Material and Disposal of Packing Material

IMPORTANT: IF THE PACKAGE WITH RADIOACTIVE MATERIAL IS DAMAGE/WET OR IF CONTAMINATION IS SUSPECTED, DO NOT MOVE OR OPEN THE PACKAGE, AVOID SPREADING THE CONTAMINATION. CALL THE RADIATION SAFETY OFFICE IMMEDIATELY. EXTENSION NUMBERS 1647, 1648 OR 1558.

Name of PI: _____ PO#: _____
Name of person receiving isotope: _____ Date received: _____
Laboratory number: _____ Name of Isotope (Ex. ^{35}S): _____
Chemical Name: _____ Amount of isotope (mCi or uCi): _____
Approved by: _____ Date of approval: _____
Condition of Package: Damaged, Yes _____ No _____
Is the package labeled as a W I, Y II, or Y III? Yes _____ No _____
Comparison of the packing slips and vial contents: Does not agree _____ Agrees _____

Instruments used for contamination surveys:

A. Wipe survey: For the following radioisotopes ^{3}H, ^{14}C, ^{32}P, ^{35}S and ^{125}I

_____Liquid Scintillation Counter _____Location 3rd Floor: Model LS 6500 *Serial #* 7069580
_____Liquid Scintillation Counter _____Location 6th Floor: Model LS 6500 *Serial #*7070616

Items	Trigger level < 200 dpm/100cm² Beta or Gamma (dpm)
1. Blank or Control	
2. Box Exterior	
3. Box Interior	
4. Radioactive Plastic Container	
5. Radioactive Vial (stock solution)	

Contamination found No _____ Yes _____ If yes, state amount: _____ (dpm)

B. Geiger Muller (GM) survey: ***For the following radioisotopes ^{32}P, ^{35}S and ^{125}I***, Magnesium Uranyl Acetate, Uranyl Acetate, Uranyl Nitrate, Uranyl Formate Uranyl Oxalate ect.)

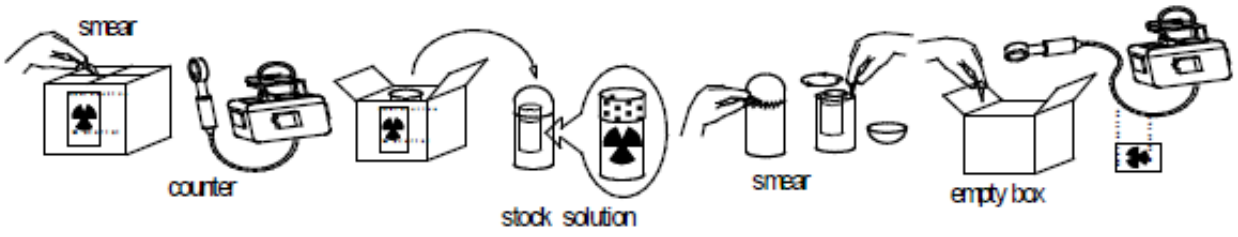
Scale of GM for survey: _____ mR/hr Series #_____ Model_____
Probe: Series_____ Model_____

Items	Surface (mR/hr)	1 meter (mR/hr)
Background		
Box 1		
Box 2		

Contamination found No _____ Yes _____ If yes, state amount: _____ (mR/hr)

Please note: Before disposing of shipping container:

_____ Deface radioactive labels or wording, dispose of in regular trash.
_____ If shipping container is contaminated, dispose of as radioactive waste.



UNIVERSITY OPF PUERTO RICO
MEDICAL SCIENCES CAMPUS
RESEARCH AREA

*** ISOTOPE INVENTORY IN REFRIGERATOR (FREEZER) or Safety Cabinet**
(An Inventory for Each isotope) (Rev June 2017)

Nome of Principal Investigator: _____ Laboratory Number: _____
Department: _____
Radioisotope: _____

Including Magnesium Uranyl Acetate, Uranyl Acetate, Uranyl Nitrate, Uranyl Formate Uranyl Oxalate ect.)

Isotope	Name of Compound	Lot #	Date Received	Activity Received (mCi / uCi / gr)	Activity Used (mCi / uCi / gr)	Activity Remaining (mCi / uCi / gr)	Date Vial was Removed	Initials

*** This inventory should be use for each isotope received in the laboratory and be posted on the refrigerator or freezer.**

UNIVERSITY OF PUERTO RICO
MEDICAL SCIENCES CAMPUS
RADIATION SAFETY OFFICE
(787) 758-2525, extension 1687 or 1688

RADIOISOTOPE MANAGEMENT INVENTORY LOG SHEET
(Use a different sheet for each compound) (Rev June 2020)

Name of Principal Investigator: _____ Department: _____ Laboratory Number: _____
Isotope/Name of chemical:_____

Radioactive Material Received			Radioactive Material Used				Radioactive Waste Generated			
Date Received	Amount Received uCi / mCi / gr	Initials	Date Removed	Amount Removed uCi / mCi / gr	Amount Remaining uCi / mCi / gr	Initials	Container ID	Solid Waste (uCi) / gr	Liquid Waste (uCi) / gr	Pickup date

UNIVERSITY OF PUERTO RICO
MEDICAL SCIENCES CAMPUS
RESEARCH AREA

RADIOACTIVE WASTE PICK UP SHEET OR DISPOSAL BY DECAY IN LABORATORY

(Radioactive Waste from laboratories picked up by the Radiation Safety office, MSC, UPR) (Rev August2011)

Name of Principal Investigator: _____ **Laboratory Number:** _____
Department: _____

Pick-Up									Disposed after 10 half-lives of the longest-lived radioisotope have transpired				
Date Stored	Name (Isotope and Chemical)	Solid Waste (# of containers)	Activity (µCi)	Liquid Waste (# of gallons)	Activity (µCi)	Initials Laboratory Personnel	Date Pick-Up	Initials Radiation Safety Office	Date Disposed	Label Defaced (X)	BKG (mR/hr)	Count Rate (mR/hr)	Initials

Note: Radioactive waste that has decayed such as P32, S35 and I-125 can be disposed of as ordinary trash and has to be documented. However the waste generated from radioisotope mixed with hazardous chemicals will be treated as hazardous waste. First the waste should be treated as radioactive waste for decay. After the decay process it should be treated as hazardous waste and has to be dispose of by an authorized company.

UNIVERSITY OF PUERTO RICO
MEDICAL SCIENCES CAMPUS
RESEARCH AREA

RADIOACTIVE WASTE PICK UP SHEET OR DISPOSAL BY DECAY IN LABORATORY

(Radioactive Waste from laboratories picked up by the Radiation Safety office, MSC, UPR) (Rev August2020)

Name of Principal Investigator: _____ **Laboratory Number:** _____
Department: _____

Pick-Up									Disposed after 10 half-lives of the longest-lived radioisotope have transpired				
Date Stored	Name (Isotope and Chemical)	Solid Waste (# of containers)	Activity (µCi)	Liquid Waste (# of gallons)	Activity (µCi)	Initials Laboratory Personnel	Date Pick-Up	Initials Radiation Safety Office	Date Disposed	Label Defaced (X)	BKG (mR/hr)	Count Rate (mR/hr)	Initials

Note: Radioactive waste that has decayed such as P32, S35 and I-125 can be disposed of as ordinary trash and has to be documented. However the waste generated from radioisotope mixed with hazardous chemicals will be treated as hazardous waste. First the waste should be treated as radioactive waste for decay. After the decay process it should be treated as hazardous waste and has to be dispose of by an authorized company.

RADIOACTIVE WASTE LABEL

Name of PI:	Radioisotope:
Name of User:	
Laboratory #: / Telephone & ext.#:	
Date of last deposit:	Description: Vials Liquid: (_____) (_____) Solid: (_____)
Only for Radiation Safety Office:	Activity:

RADIOACTIVE WASTE LABEL

Name of PI:	Radioisotope:
Name of User:	
Laboratory #: / Telephone & ext.#:	
Date of last deposit:	Description: Vials Liquid: (_____) (_____) Solid: (_____)
Only for Radiation Safety Office:	Activity:

MEDICAL SCIENCES CAMPUS UNIVERSITY OF PUERTO RICO
LABORATORY SAFETY OFFICE IN RESEARCH (OSLI)

DECOMMISSIONING RECORD

Name Principal Investigator:	Department:	Laboratory:				
Building	**Surveyer:**	**Isotopes permitted**				
		H^3	C^{14}	P^{32}	S^{35}	I^{125}
		i				
SURVEY METER RESULTS						
Instrument:	**Model:**	**Serial Number**				
Geiger Muller						
Surface Type:	**Measurement and units:**	**Comments:**				
SWIPE TEST RESULTS						
Instrument:	**Model:**	**Serial Number**				
Location:	**Results: Trigger level 2000 dpm/cm²**	**Comments:**				
Facility Diagram attached:		**Swipe report Attached:**				
Yes	**No**	**Yes**	**No**			

According to the results indicated above this area is decommissioned and released for unrestricted use by the approval of the Radiation Safety Committee.

Radiation Safety Officer **Date**