Marine Biological Laboratory

THE UNIVERSITY OF CHICAGO

RADIATION SAFETY MANUAL

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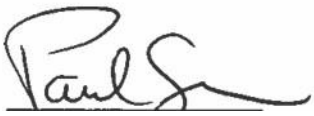
APPROVAL:



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1 INTRODUCTION

The Marine Biological Laboratory (MBL) uses radioactive materials and radiation generating devices for research and academic purposes. The MBL is committed to maintaining radiation exposures to staff, students, and members of the general public *As Low As Reasonably Achievable (ALARA)*, and ensuring compliance with regulations set by the Massachusetts Department of Public Health's Radiation Protection Program (MRCP) and the U.S. Nuclear Regulatory Commission (NRC).

1.1 Purpose

The Radiation Safety Manual describes the procedures for personnel who use radioactive materials or radiation-generating devices in research and teaching laboratories at MBL. The Manual also complements the required Radiation Safety Training that all Radiation Workers must complete.

All Authorized Users of licensed radioactive materials should maintain a current copy of the Radiation Safety Manual in their approved laboratory, where it is readily accessible to all Radiation Workers.

1.2 Scope

The Radiation Safety Manual applies to all persons who are involved in the use of radioactive materials and radiation-generating devices at the MBL. They include Principal Investigators/Senior Scientists, Course Directors/faculty members, MBL Fellows, postdoctoral researchers, visiting scholars, interns, and students.

1.3 Radiation Safety Manual Review

The Radiation Safety Officer (RSO) shall review the Radiation Safety Manual for effectiveness and update it, as necessary. The RSO may also seek advice from the Authorized Users, Radiation Workers, or affiliated partners.

1.4 ALARA Policy

The MBL endorses the policy of minimizing radiation exposures to individuals or releases of radioactivity to the environment resulting from work with radioactive materials. This policy is known as *ALARA (As Low As Reasonably Achievable)*. The fundamental goal of ALARA is maintaining exposures as far below the regulatory limits as practical with consideration of economics, state of technology, and other societal and socioeconomic considerations.

The Radiation Safety Committee (RSC) is responsible for maintaining oversight of activities under the ALARA plan. The Committee reviews measures to achieve ALARA. The current ALARA dose limit for personal exposures at the MBL set by the RSC is 10% of any of federal, state, or local regulatory agency limit. The RSC

develops policies, approves Authorized Users, and reviews procedures. These actions provide instructions and guidance to faculty, staff, and students in the implementation and responsibilities of ALARA.

2 ROLES AND RESPONSIBILITIES

2.1 Radiation Safety Committee

The RSC is responsible for providing oversight of the Radiation Safety Program. The committee establishes policies and procedures governing the use of radiation sources at MBL. The committee reviews and approves all requests for authorization to use radioactive materials and radiation generating devices within the MBL. No person may order, receive, use, or bring into MBL any radioactive material or radiation generating device without prior authorization from the RSC.

The RSC membership includes the RSO and MBL scientists or faculty members who are knowledgeable in the use of ionizing and non-ionizing radiation sources. The RSC size and composition shall be large enough to represent the broad spectrum of radioactive material users across the MBL's research and teaching community. The Director of the Division of Research shall determine the range of RSC representation by encouraging Resident Scientists, Whitman Scientists, Course Directors, and faculty members to nominate knowledgeable radiation users from the research and teaching community at MBL.

The RSC shall meet at least twice during the calendar year. The committee shall maintain records of the minutes and make them available for review by regulatory agencies during routine inspections.

The RSC is responsible for the following:

- Be familiar with all pertinent MRCP and NRC regulations.
- Review the training and experience of the RSO and the proposed Authorized Users to determine that their qualifications are sufficient to enable the individuals to perform their duties safely, and are in accordance with NRC and MRCP regulations and the conditions of MBL's Radioactive Materials License.
- Review and approve or disapprove all requests for authorization to use radioactive material and radiation generating devices within the MBL.
- Review records and reports from the RSO, results of regulatory inspections, written procedures, incidents and laboratory audits performed by the RSO.
- Review MBL operational programs to ensure that all persons whose duties may require them to work in, or frequent areas where radioactive materials are used (e.g. MBL Security, Housekeeping, Plant Operations & Maintenance personnel) are appropriately instructed as required by the federal and state regulations.
- Recommend corrective action to address deficiencies identified in the Radiation Safety Program Audit.
- Maintain written minutes of all committee meetings.

2.2 Radiation Safety Officer

The RSO is responsible for the implementation and maintenance of the Radiation Safety Program, including periodic update of the Radiation Safety Manual. The RSO's duties and responsibilities also include ensuring compliance with applicable local, state, federal regulations and the conditions of the MBL license.

The RSO will keep the RSC, Safety Committee, and MBL senior management informed of any significant radiation safety issues. The RSO reports all issues concerning audits, inspections, licensing, radioactive waste management, and resource needs of the Radiation Safety Program to the RSC, Safety Committee, Director of Division of Research and the Directory of Facilities, as necessary.

Specific duties and responsibilities of the RSO are as follows:

- Oversee all activities involving radioactive material, including surveys of all areas in which radioactive materials are used or stored.
- Investigate accidents or unusual occurrences involving radiation sources and recommend appropriate corrective actions.
- Liaise with federal and state regulatory agents responsible for radiation safety.
- Maintain inventory records to account for all radioactive materials and radiation generating devices entering and leaving the MBL.
- Review all requests for new Authorized Users of radioactive material and requests for amendments to existing Authorizations.
- Review and approve all requests for the procurement of radioactive materials.
- Maintain records of all isotopes purchased and ensure that licensed radioactive material that the MBL possesses is limited to the types and quantities of material listed on the license.
- Conduct radiation safety training for all Authorized Users and Radiation Workers.
- Manage personnel monitoring program for all radiation safety activities at MBL, including providing monitoring badges and maintaining all necessary records.
- Manage radioactive material waste storage and disposal program.
- Perform annual audit of the Radiation Safety Program to ensure that MBL is complying with all applicable MRCP and federal regulations and conditions of the MBL Radioactive Materials License.
- Perform leak tests on all sealed sources and calibration of radiation survey meters/detectors and liquid scintillation counters.
- Immediately terminate any unsafe condition or activity found to be a threat to public health and safety or property.

2.3 Authorized User

The Authorized User is a Principal Investigator/Senior Scientist/Course Director or faculty member who has been approved by the RSC to use and supervise the use of radioactive materials or radiation generating devices in approved

research or teaching laboratories. Authorized Users have relevant training and experience in the use of radiation sources in their laboratory's research activities.

Specific responsibilities of the Authorized User include:

- Ensure that all individuals within laboratory are listed users and have received appropriate radiation safety training by the RSO before working with radioactive materials or radiation generating equipment.
- Supervise safe use of radioactive materials in laboratories including that radioactive materials are properly labeled and secured when in storage.
- Follow and enforce established policies and procedures as outlined in this manual.
- Ensure visitors, students, or staff who are allowed access to areas designated for radiation use follow all applicable rules and are informed of any potential radiation hazards.
- Inform all Radiation Workers of the MBL Declared Pregnant Worker notification form and of their rights pertaining to that notification.
- Minimize generation of radioactive waste and restrict creation of mixed radioactive/chemical or biological wastes.
- Maintain accurate radioactive use records and created waste records.
- Contact the RSO in the event of an accident or unusual occurrence including loss of radioactive material, spills, or discharges, or internal exposure to radioactive material.

2.4 Radiation Worker (User)

Radiation Workers (Users) include scientists, laboratory personnel, and students engaged in laboratory research or teaching activities involving the use or handling of radioactive materials or radiation generating devices. The Radiation Workers should work under the supervision of the Authorized User. All Users must be trained by the RSO prior to handling radioactive materials.

Radiation Worker must:

- Comply with all applicable regulations and provisions of this manual.
- Keep exposures to ionizing radiation As Low As Reasonably Achievable (ALARA).
- Label all radioactive samples, contaminated equipment, and waste containers.
- Maintain constant surveillance of radioactive material in use to prevent unauthorized removal or use of material.
- Notify the RSO immediately of any personal contamination, internal exposure or a major spill involving radioactive materials.
- Perform contamination surveys of isotope use areas using appropriate survey instruments.
- Perform decontamination of work area and equipment when necessary, based on the results of the contamination surveys.

- Wear proper personal protective clothing (gloves, laboratory coat, and eye protection) whenever working with radioisotopes. All PPE should be kept inside the designated radioactive material use area.
- If applicable, wear the radiation monitoring dosimetry badge and quarterly return to RSO.
- Notify the RSO and Principal Investigator of a declared pregnancy as soon as possible.

3 AUTHORIZATION TO USE RADIOACTIVE MATERIALS

The possession and use of radioactive materials at MBL is authorized by the MBL's Radioactive Materials License issued by the MRCP. Each Principal Investigator/faculty member or Course Director is required to have a protocol approved by the RSC to order, possess and use radioactive materials or radiation generating devices at MBL.

Principal Investigators/faculty members planning to conduct research using radioisotopes in experimental animals must contact the MBL Institutional Animal Care and Use Committee (IACUC). Approval of the research protocol by both the RSC and IACUC is required for the particular protocol before research involving the use of radioisotopes in animals begins.

The use of radioactive materials in human subjects is not permitted under the conditions of the MBL's Radioactive Materials License.

3.1 Authorization Procedure

1. The applicant must complete and return "*Application for Permit to Use Radioactive Materials*" to the RSO at safety@mbl.edu (see appendix).
2. The RSO will meet with the applicant to review the application, discuss radiation safety aspects of the research protocol, coordinate training, and assist in the setting up of the laboratory for radiological work.
3. The RSO will submit the application to the Radiation Safety Committee for approval review.
4. The RSO will issue to applicant a "*Radioactive Material Use Permit"* to be kept on file and posted at entrance to laboratory.
5. The radioactive material permit is valid for one year.

3.2 Authorization Amendments

The Authorized User may submit a written request for amendments to the Radioactive Materials User Permit to the RSO. Amendments include changes to experimental protocols, approved laboratory locations, radioisotope purchase or possession limits, proposed uses, and laboratory personnel who work with radioactive material.

The RSO will review the requested amendment with the Authorized User. The RSO may approve simple changes in experimental protocol, purchase limits, laboratories, and users. For major modifications (new isotopes or location), the RSC Chair will at their discretion approve it or forward it the RSC for full review.

3.3 Authorization Termination

Authorization to use radiation sources terminates when the Authorized User leaves the MBL or at the Permit expiration date. The Authorized User must notify the RSO at least 30 days before leaving the MBL or terminating work with radioactive materials or radiation generating devices.

The Authorized User must ensure proper transfer of radioactive materials, devices, and records, and must complete appropriate laboratory exit surveys before leaving the MBL or terminating the authorization.

Specifically, the Authorized User shall cooperate with the RSO and ensure that:

- All radioactive materials still in the Authorized User's possession are disposed of as radioactive waste or transferred to RSO before leaving the MBL.
- The laboratory is cleaned and free of radioactive contamination. The RSO will conduct an exit contamination survey of laboratory and equipment to ensure no contamination.
- Radiation caution signs, posted User Permit, and labels are removed.
- Personnel monitoring dosimetry is discontinued and returned to RSO, as applicable.

3.4 Radiation Safety Training

All radioactive materials users must complete the Radiation Safety Training, provided by the RSO, before using radioactive materials.. The training covers general radiation safety and radioactive material use as recommended by US NRC. All individuals who plan to use radioactive materials at the MBL must attend the Radiation Safety Training, regardless of their prior experience. In addition, the Authorized User (Permit Holder) must provide laboratory-specific "hands-on" training to each user.

A refresher Radiation Safety Training is required every year. All Authorized Users and Radiation Workers must complete the training by attending one of the Radiation Safety Training sessions offered by the RSO.

Employees who may need access to areas containing radioactive material will be provided with radiation safety awareness training. These employees include the Plant Operations & Maintenance (POM), Custodial, Animal Care Facility, Shipping & Receiving Department, and MBL Campus Security personnel. The RSO will maintain on file the attendance records for all radioactive material training.

4 PURCHASE OF RADIOACTIVE MATERIALS

Any receipt of radioactive materials, whether a purchase or gratis shipment, must be approved by the RSO before shipment. The MBL must track and control all radioactive materials received to ensure that its possession limits are not exceeded.

4.1 Authorization to Receive Radioactive Materials

1. No one may order, receive, use, or bring into MBL any radioactive material without prior authorization from the RSC. This includes purchases from commercial vendors, other academic or research institutions, or transfers from colleagues or gratis shipment from commercial vendors.
2. Only Authorized Users with an approved protocol and a valid Radioactive Material User Permit are permitted to order radioactive materials.
3. All radioactive material orders must be approved by the RSO and placed through the MBL Purchasing Department.

4.2 Authorized Limits

The MBL Radioactive Material License restricts MBL to activity limits specific to the isotope in use. The radioactive material procurement and inventory control process prevents these activity limits from being exceeded.

Each Authorized User’s Permit specifies a limit of radioactive isotopes to be used in their laboratory. Requests to purchase isotopes that would result in exceeding a specific Authorized User's limit require an amendment to the User's permit and approval by the RSC.

4.3 Purchasing Radioactive Material

1. All radioactive orders must be submitted to the RSO with a completed MBL purchase order form which only includes radioactive material items.
2. The RSO will review the order to ensure the acquisition of the radioactive material will not cause MBL to exceed the licensed possession limits.
3. Purchases shall be limited to the radioactive materials and quantities specified in the Authorized User’s radioactive material protocol approved by the RSC.
4. Upon approval of purchase, the RSO will place the order with the vendor.

4.4 Internal Transfers of Radioactive Materials

All transfer of licensed materials from one Authorized User to another must have prior approval from the RSO. Upon approval, the RSO will create a new Accountability form for the exchange. All transfers shall be done in a way that minimizes the probability of spillage or breakage. Double containers should be used, including suitable shielding, for such transfers. Contact the RSO prior to any internal transfer of licensed material.

4.5 External Transfers of Radioactive Materials

Licensed radioactive material shall not be transferred or shipped from MBL to another institution without the approval of the RSO. Such transfers or shipments must be packaged and labeled according to DOT requirements. The receiving institution must be licensed for the radioactive material and be willing to accept the liability related to the receipt and possession of the radioactive material. Contact the RSO prior to any external transfer of licensed material.

4.6 Ordering Radioactive Materials for Delivery to Other Institutions

Radioactive materials ordered for delivery to another institution shall not be ordered under the MBL License. Such materials must be approved for delivery by the recipient institution and ordered under their radioactive materials license. The MBL laboratory ordering these radioactive materials is required to maintain records of the purchase.

5 RADIOACTIVE MATERIAL RECEIPT AND ACCOUNTABILITY

All radioactive materials shall always be accounted for and secured. The MBL requires each Authorized User to maintain accountability for all radioactive materials purchased or received under their Radioactive Material User Permit. The RSO with support of the RSC will provide oversight in maintaining accountability and compliance with pertinent federal and state regulations and the conditions of the MBL License.

5.1 Security of Radioactive Material at MBL

Each Authorized User has the responsibility to maintain radiation sources (stock solutions, radioactive materials samples, and radioactive waste) under constant surveillance and control.

1. Store radioactive materials only in areas approved by the Use Permit.
2. Radioactive materials are used or stored must be locked when unattended. Any of the following methods is acceptable:
   - Store radioactive materials in a locked laboratory (or inner locked room).
   - Store radioactive material in a locked container such as a freezer, refrigerator or other container that cannot be removed.
   - Store radioactive material in a lock box or specialized container on a bench or inside a freezer or fridge. These containers must be physically secured to an immovable object as not to be removed from the laboratory.
3. The Authorized User must promptly report to the RSO if any licensed radioactive material (stock solution vials, sealed sources, radioactive waste) is suspected or found to be missing from the designated Radiation Material Area.

6 TRANSPORTING AND SHIPPING RADIOACTIVE MATERIALS

Transportation of radioactive materials is regulated by the MRCP, U.S. DOT, United States Postal Service (USPS), radioactive materials license of the destination institution, and other applicable local regulations.

The shipping of radioactive materials is regulated domestically as "*hazardous materials*" by U.S. DOT and internationally as "*dangerous goods*" by the International Air Transportation Association (IATA).

To ensure MBL complies with all national and international regulatory requirements, all transportation and shipping of radioactive materials must first be approved by the RSO.

6.1 Transporting Radioactive Material at MBL

Radioactive materials may be transported to an Authorized User in an MBL building provided that the following conditions are met:

- Radioactive material may not cross a public way without proper DOT packaging. Instead, use of the tunnel between Lille and Rowe should be used to avoid a public way.
- The radioactive material is tightly sealed in a leak-proof, shatter-resistant container.
- Verify that the external surface of the inner container is free of radiation contamination (i.e., emitted dose rate is less 2 mrem per hour).
- Place a radioactive material label on the vial that lists the radioisotope, activity, and reference date.
- Place the radioactive material inner container inside a second shatter-resistant container with adequate absorbent material to absorb all the radioactive material.
- Confirm that there is no removable contamination on the surface of the container, as determined by a wipe test.
- During transportation, the package must remain in the possession of Authorized User as authorized by the RSC to use the radioactive material.

6.2 Transfers between MBL and Other Institutions

All transfers and transportation of radioactive materials off MBL Campus must be approved in advance by the RSO. Transportation of radioactive materials in private vehicles is strictly prohibited by federal and state regulations.

1. The Authorized User must contact the RSO prior to committing to ship a sample of radioactive material.
2. The RSO will contact the other institution to obtain a copy of their radiation license and to arrange for receipt of the package.
3. The Authorized User is responsible for ensuring that the shipment is properly described.

4. The RSO will advise the Authorized User and laboratory personnel about packaging and shipping requirements.
5. The RSO will label, survey and inspect the package prior to shipment. The Authorized User is responsible for updating the inventory.
6. A commercial carrier such as Federal Express, World Courier, Inc., or United Parcel Service (UPS) must be used to ship radioactive materials.

7 POSTING AND LABELING RADIOACTIVE MATERIAL AREAS

Any MBL room containing any amount of licensed radioactive material is a Radioactive Materials Area (RMA) and the room must be posted appropriately. The MBL shall meet the laboratory posting guidelines and container labeling requirements established under the Commonwealth of Massachusetts regulation (105 CMR 120).

7.1 Laboratory Posting Requirements

- Each room where radioactive materials are stored or used must prominently display an 8 x 10 inches "CAUTION RADIOACTIVE MATERIALS" sign and a label indicating “NO EATING OR DRINKING PERMITTED” at all entrances.
- All rooms must be posted with a Laboratory Door Placard with emergency contact names and phone numbers.
- All chemical fume hoods used for radioactive materials shall be clearly labeled with a "CAUTION RADIOACTIVE MATERIALS".
- All radioactive material workbench areas shall be clearly identified using "CAUTION RADIOACTIVE MATERIALS" tape as a boundary.
- All signs shall use the colors magenta, purple, or black on a yellow background.
- All storage containers that are not located in secured laboratory shall be individually posted with their stored inventories and must be kept locked.

7.2 Container and Equipment Labeling

MBL requires labeling of all containers of radioactive material or any piece of equipment in which radioactive material is to be in contact, regardless of the level of radioactivity.

- Although the regulations in 105 CMR 120 require labeling only containers above the specified limits, MBL requires that all containers be labeled regardless of the total radioactivity of the contents.
- Each container that holds radioactive materials must have a durable, clearly visible label bearing the radiation warning symbol and the words "CAUTION RADIOACTIVE MATERIAL."
- All labels must indicate the contents of the container including the isotope, the amount of activity, and the date.

- All labels shall use the colors magenta, purple, or black on a yellow background.
- Containers used temporarily during laboratory procedures (e.g. pipettes) do not require labeling provided the user is present and the room is properly posted.
- All refrigerators, freezers, and cabinets used for storage of radioactive materials shall have a "CAUTION RADIOACTIVE MATERIALS" label.
- All storage containers that are not located in a secured laboratory shall be individually labeled with their stored inventories.
- Radioactive tape appropriate for labeling containers is available from the RSO. Under no circumstances should the tape be used for any purpose other than for proper labeling of radioactive items.
- Once cleared as not contaminated, remove or deface all radioactive material labels prior to disposing containers as waste or equipment/tables no longer to be used for radioactive material work.

8 DOSES LIMITS AND PERSONAL MONITORING

The MBL is required by MRCP regulations to keep doses *As Low As Reasonably Achievable* (ALARA). ALARA limits are established as a goal for occupational exposures.

All Radiation Workers should minimize the potential for radiation exposure by following prudent radiation protection principles. Radiation Workers will follow administrative controls designed to limit radiation exposures. Engineering controls should be used whenever feasible. Personal Protective Equipment (PPE) should be used to limit potential radiation exposures.

The MBL does not allow access to its research and teaching facilities by members of the general public. MBL's use of radioactive materials is restricted to controlled areas (e.g., locked laboratory and classroom facilities). The MBL research and teaching activities will be conducted such that doses to individual members of the public will be within the regulatory limits.

8.1 Occupational Exposure Limits

Occupational exposures at the MBL will be maintained within the limits listed below.

	Annual Limit (mrem per year)	**ALARA Limit (mrem per year)**
Whole body	5,000	500
Skin and Extremities	50,000	5,000
Lens of Eye	15,000	1,500
Declared Pregnant Worker	500	50
Minors	500	50
Member of General Public	100	100

The major concern for occupational exposure to radiation at MBL is related to internal intake of radioactive materials. Internalization occurs when radioactive materials enter the body via a route of entry. The primary routes of entry are inhalation, absorption, ingestion, and injection.

The procedures and policies described in this Radiation Safety Manual are aimed at minimizing the effective uptake of radioactive materials.

8.2 Declared Pregnant Workers

The Nuclear Regulatory Commission (NRC) issued a rule limiting fetal radiation dose received as a result of a pregnant worker's occupational exposure to 500 mrem in the gestation period. 105 CMR 120 requires that lower exposure limits be imposed on declared pregnant women to control the dose to the embryo/fetus. A woman may declare her pregnancy following procedure below:

(a) It is the responsibility of the woman to notify the RSO of the pregnancy, if desired. The declaration may be rescinded at any time and for any reason.

(b) Radiation Worker must submit a "DECLARATION OF PREGNANCY" form (see appendix) to the RSO. At the woman's discretion, she may inform her Principal Investigator/Supervisor of the pregnancy. The MBL shall maintain the declaration and any dose records to the embryo/fetus as confidential.

(c) The RSO will assess potential doses, evaluate potential exposures from ionizing radiation, and/or review the individual's radiation exposure history. If this process identifies potential exposure to the embryo/fetus, the individual will be contacted. Recommendations on minimizing radiation exposure may be made on an individual basis after this review.

(d) The MBL strives to keep radiation doses to potentially exposed individuals ALARA. While the radiation dose limit for occupationally exposed individuals

is 5,000 mrem per year, all the radiation users at MBL have had an annual dose of less than 100 mrem.

(e) If applicable, the individual shall be required to wear a radiation badge in the abdominal region to evaluate doses to the embryo/fetus separately from the doses to the chest.

8.3 External Monitoring

Monitoring of external radiation exposure is required to ensure doses are maintained ALARA for anyone handling radioactive materials, sealed or unsealed.

1. External exposure monitoring (whole body) will be required for any Radiation Worker working with energetic radioactive materials (e.g. > 250 keV).
2. Finger ring dosimeters are required when handling 10 mCi or more of P-32, and in other situations where hand exposures may be significant.
3. Monitoring devices will not be issued to those individuals handling only low energy beta emitters (H-3, C-14, S-35, and P-33) or alpha emitters. Whole body dosimeters and ring badges do not respond to the weak beta radiation from these isotopes.
4. Radiation badges issued for any reason, whether required or requested, must be worn whenever the user is near any source of radiation.

Dosimeters are delivered to each laboratory by the RSO as soon as they are received from the vendor (Landauer, Inc., Glenwood, Illinois). Each monitored individual shall exchange his/her new radiation dosimeter for the old one. Prompt return of dosimeters allows the RSO to effectively monitor radiation exposures. The RSO will collect and send the dosimeters to the external vendor for processing.

Radiation exposure doses for each calendar year will be made available to each monitored individual. Individuals may obtain their dosimetry records at any time upon request to the RSO. Any routine dosimeter with an exposure in excess of 100 mrem will be reviewed by the RSC.

Access to an individual's dose records must be restricted to that individual and to individuals with responsibility for ensuring radiation safety at the MBL (RSO, RSC members, Authorized User, Principal Investigator, Course Director, or Laboratory Supervisor). Access to dosimetry records by other parties may be granted only with written authorization from the monitored Radiation Worker. If dosimetry reports are posted, personal information such as name, social security number or birth date must be removed prior to posting.

8.4 Bioassay Requirements

Radioactive materials can be taken up internally when volatile or other airborne radioactive materials are inhaled and when radioactive materials are absorbed through skin or ingested. Internal uptakes may occur when laboratory personnel

unknowingly handle contaminated objects, when penetration occurs through highly contaminated gloves, or when spills occur.

Bioassays are conducted to monitor internal exposure of radioactive materials due to inhalation or ingestion during experimental procedures. The RSO may request bioassays when widespread contamination has occurred in a laboratory, and when skin contamination has occurred. A Radiation Worker may request a precautionary bioassay at any time. For specific radioisotopes, bioassays may involve urinalysis or external thyroid counting.

Urine Bioassays:

Individuals involved in operations which use tritium (H-3) in a form other than a sealed source or metallic foil, in amounts of 100 mCi or greater, should submit urine samples for analysis, which should be taken 24 hours after a single experiment. Arrangements for this service should be made through the RSO.

Bioassays may be requested by the RSO for individuals using isotopes other than tritium or as follow-up to unusual situations and spills. A woman may decide or be asked to submit a urine sample when a pregnancy is declared.

Thyroid Counts:

The control of radioiodine can present numerous problems due to its volatility and low permissible concentrations in air. Individuals working with significant quantities of radioactive iodine should have thyroid counts on a frequency established by the RSO. Thyroid counts are required for all individuals performing iodinations both before, and 6 to 72 hours after, an iodination is performed. Quarterly counts may be required for individuals who work with iodine but do not actually perform iodinations.

If there is an accident or spill involving radioactive iodine, contact the RSO for monitoring the potential thyroid uptake. Radiation workers with declared pregnancies may decide, or be required, to have a background thyroid count and periodic counts for the duration of gestation.

9 CONTROL OF PERSONAL EXPOSURE

All Radiation Workers must employ good laboratory practices in their radioactive material use area. The Authorized User is responsible to supervise all users to ensure safe use of radioactive materials in the laboratory. Control measures include:

- Personal protective equipment shall be worn when working with radioisotopes. The minimum personal protective equipment required is laboratory coat, safety glasses and disposable gloves. Use of two layers of disposable gloves is recommended.
- Loose clothing or clothing that exposes body areas that could trap radioactive material (open-toe footwear) must not be worn in the laboratory.
- Absorbent materials, with a plastic underlining or on a spill tray, shall be used on bench tops and work areas where radioactive materials are used and handled.

- Secondary containers must be used to prevent spillage and contamination spread in the event that the primary container fails to contain the radioactive material.
- Spills of radioactive materials shall be contained immediately with the area decontaminated before work resumes. The Authorized User and RSO must be notified in the event of a spill.
- Wash hands thoroughly after using radioactive materials, before going on breaks, and at the end of the workday.
- Eating, drinking, smoking, or application of cosmetics in laboratories or areas where radioactive material is used or stored is strictly prohibited.
- Calibrated portable radiation survey meters shall be used to both monitor work areas and personnel. Surveys must be completed after each use of radioactive material (except of tritium).
- Wipe surveys shall be performed at least monthly in each laboratory or area using radioactive materials, and after each tritium use exceeding 10 µCi, to ensure contamination levels are below those specified by the RSO. More frequent surveys may be required in certain areas by the RSO or Authorized User, as necessary, to ensure compliance.
- When leaving the laboratory, secure all radioactive containers or the laboratory door.

10 CONTAMINATION SURVEYS AND MONITORING

Contamination surveys are performed to identify areas of contamination that might result in exposure to radiation doses to workers or any other individual entering area. Radiation survey instruments (Geiger Counters/meter survey) are used only to measure the radiation for which their calibrations are valid (certain isotopes). Wipe samples measured on a liquid scintillation counter will identify removable contamination. Wipe tests are the most useful and most sensitive method of detecting low-level contamination in the laboratory (most isotopes).

Contamination surveys should be performed:

- To evaluate radioactive contamination that could be present on surfaces of floors, walls, laboratory furniture, and equipment.
- After 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.
- 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.

10.1 Performing a Meter Survey

The Geiger-Mueller (GM) probe is the most common radiation detection instrument. The radiation detection causes both visual and audio responses. The survey meter detects radiation events and does not differentiate types of energies or radiation.

The GM probe is used for detecting beta emitters (e.g., P-32, S-35, and C-14). Low energy beta emitters such as H-3 are not detectable since they do not have enough energy to penetrate the window. Instead, use a liquid scintillation counter.

Geiger Mueller with Pancake Probe

Scintillation Probe

A hand-held scintillation detector absorbs radiation and emits light that is converted into a radiation measurement. A scintillation probe is used on survey meters like the Ludlum 3 for low energy photons (gamma rays e.g. I-125) and x-rays less than 40 keV). The efficiency of a low energy scintillation probe for the detection of I-125 is about 30-35%.

Radiation Survey Meter and Probe Choice

Isotope	Emission	Energy (MeV)	Detector	Probe	Pancake GM Efficiency at 1 cm
H-3	beta	0.0186	LSC	N/A	Not detectable
C-14	beta	0.156	Survey Meter	Pancake GM Probe	1%–5%
P-32	beta	1.709	Survey Meter	Pancake GM Probe	20%–25%
P-33	beta	0.249	Survey Meter	Pancake GM Probe	7%–10%
S-35	beta	0.167	Survey Meter	Pancake GM Probe	3%–8%
Ca-45	beta	0.257	Survey Meter	Pancake GM Probe	6%–8%
I-125	gamma	0.035	Survey Meter	Scintillation	< 0.01%
I-131	gamma, beta	0.364	Survey Meter	Pancake GM Probe, Scint.	< 1%

Procedures for Meter Survey:

1. Check the survey meter's battery by turning the meter knob to the battery test position. If the battery is sufficiently charged, the meter needle will swing to the BATTERY TEST position on the meter face. Replace the batteries if they are low.
2. Perform an operational check the first time you use the meter each day or when you suspect it may have been misused or damaged.
3. Check the calibration sticker on the side of the meter and note what the expected reading for the operational check source should be.
4. Switch the meter ON and turn the meter's multiplier switch to a setting that will measure the check source and will provide a mid-scale reading but will not cause the needle to swing beyond full scale.
    - For a Ludlum GM survey meter the multiplier knob should generally be set to the X1 position.
    - Place the probe firmly against the check source on the side of the meter and note the meter response.
    - If the observed meter response differs from the expected response by more than 20%, the meter should be considered nonfunctional and should be taken out of service.
    - Take the meter to an area away from sources of radiation and note the meter background reading.
5. The background for a GM meter with a pancake survey probe should be less than 100 counts per minute (cpm) while the background reading for a meter with a scintillation probe should be less than 300 cpm.
6. If the meter's background reading is substantially greater than expected, confirm that there are no unexpected sources of radiation or radioactive materials in the vicinity. Call the RSO to report a potentially contaminated meter.
7. Do not cover the probe surface with parafilm or other protective covering. Parafilm and similar materials will shield the low energy betas from C-14, P-33, and S-35 and will prevent the meter from detecting contamination.
8. Slowly move the probe about 1 centimeter above the area of interest.
9. If an item or area with a sustained count rate more than three times background is found, the item or area should be considered contaminated.
10. Immediately label the area or item and promptly decontaminate. If an area cannot be decontaminated, the contaminated area should be marked and labeled to indicate the isotope, date, and level of contamination.
11. When the meter survey indicates that low-level contamination may be present, a wipe survey should be performed to confirm or disprove the presence of contamination.
12. Document the survey results whenever contamination is discovered or if 250 µCi or more have been handled.

10.2 Performing a Wipe Test Survey

Wipe surveys must be performed at a minimum of monthly and upon completion of radioactive material work for each laboratory. The RSO will be responsible for conducting this testing. In the event of a spill or known contamination the laboratory should perform testing to confirm clean-up / contamination is at background levels.

The liquid scintillation counter (LSC) is used to detect low energy emitters (H-3, C-14, S-35, and I-125) and can be used to count contamination removed by wipe samples.

Procedures for Wipe Survey:

1. Wipe surveys must be performed when H-3 is used and is the survey method of choice to detect the presence of low levels of removable C-14, P-33 and S-35 contamination. Wipe surveys should also be performed to confirm the presence of contamination when a meter survey suggests that low level contamination may be present.
2. Using a piece of filter paper (about 1" in diameter) or other swab, wipe the area being surveyed. If the area is very large, subdivide it into smaller areas and use several wipes to isolate the location of contamination.
3. Place filter paper in scintillation vial and add appropriate volume of scintillation fluid. Prepare the sample for counting as suggested in the counter's operating manual.
4. Analyze the wipe samples in a liquid scintillation counter for H-3 and other beta emitters.
5. Sample activity is determined by dividing the sample count by the counter's efficiency for the isotope in question. The counter's operating manual should provide information about efficiencies and activity determination.
6. Contact the RSO at x7424 or safety@mbl.edu about using the liquid scintillation counter.

10.3 Sealed Source Leak Testing

Devices containing sealed sources of radioactive materials include gas chromatographs containing radioactive sources (i.e. Ni-63). The RSO will conduct a leak test of all sealed sources every six months. Leak test samples will be analyzed by a licensed vendor.

Procedure for Leak Test:

1. Record sufficient information on the vendor provided envelope (or other container) to identify the source to be tested.
2. Put on a pair of gloves.
3. Moisten the cotton tip swap or other suitable material with the alcohol pad.
4. Wipe the sealed source or the surface of the device housing the sealed source with swabs comprised of paper, cotton, or other suitable material. Notice: For sealed sources contained in a device, test samples are obtained when the source is in the "off" position.
5. Place swab inside a provide zip lock bag for return to vendor.

10.4 Radiation Instrument Calibration

MBL's License requires calibration of portable survey meters annually. Properly calibrated survey meters are required to perform accurate radiation contamination surveys. The RSO is responsible for overseeing the annual calibration, maintenance, and repair of all the survey equipment used in MBL.

The radiation survey meters and probes are sent to a licensed vendor (Ludlum Measurements, Inc., Sweetwater, Texas) for dose rate calibrations and repairs. The annual calibration certificate for each instrument is kept on file with the RSO.

Calibrations of the liquid scintillation counters (LSC) located in the radiation laboratory (Lillie Room 8) are validated prior to use and at a minimum quarterly by the RSO. Preventative maintenance is typically performed annually by a licensed external vendor.

11 RADIOACTIVE MATERIAL INCIDENTS

A radioactive material incident is any event that involves a loss of control over radioactive material and must be promptly reported to the RSO. Examples of such incidents include:

- Missing radioactive material.
- Unmonitored release of radioactive materials to the environment.
- Unexpected or unmonitored airborne release of radioactive materials.
- Malfunction of a radiation device or radiation generating device.
- Exposure to a radiation field greater than 25 mrem/hour.
- A spill of radioactive material.
- Receipt of a contaminated package of radioactive material.
- Personal contamination.
- A fire or flood involving radioactive materials.

Response to radiation incidents should minimize further radiation exposures or contamination; inform others of the radiation hazard, secure the area, contact the RSO x7424 and wait for further instructions from the RSO.

All Radiation Workers are responsible for reporting radiation incidents to the RSO. The individual Authorized User and Radiation Workers are responsible for handling a radiation incident. The RSO will oversee response to a radiation incident.

11.1 Response to a Spill

Small Spill:

Spills involving trace levels of radioactive material (10 µCi or less) and less than one liter, and without personal contamination or spread to non-posted areas, shall be cleaned by Radiation Workers under the direction of the Authorized User or the RSO. Clean up procedures for a small spill are as follows:

- Check all personnel for skin and/or clothing contamination with an operable survey instrument.
- Remove contaminated clothing.
- Decontaminate personnel and resurvey.
- Wear double gloves and personal protective clothing including protective shoe covers.
- Perform a final survey to document that the area has been successfully decontaminated.
- Do not allow personnel to return to work until area is cleared by the RSO.

Large Spill:

Spills in excess of 10 µCi, any spill resulting in personal contamination, spread of radioactive materials to non-posted areas, or volumes greater than one liter shall be handled according to the following procedures:

- Clear the area. If appropriate, survey all persons not involved in the spill and vacate the room.
- Prevent the spread of contamination by covering the spill with absorbent paper (paper should be dampened if solids are spilled), but do not attempt to clean it up. To prevent the spread of contamination, limit the movement of all personnel who may be contaminated.
- Shield the source only if it can be done without further contamination or significant increase in radiation exposure.
- 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.
- Contact MBL Campus Security at x7911 and notify the RSO immediately.
- Survey all personnel who could possibly have been contaminated. Decontaminate personnel by removing contaminated clothing and flushing contaminated skin with lukewarm water and then washing with a mild soap.
- Do not allow anyone to return to work in the area unless approved by the RSO.

- Cooperate with the RSO with investigation of root cause and provision of bioassay samples (as necessary).
- Follow the instructions of the RSO for decontamination techniques, surveys, provision of bioassay samples, and requested documentation.

11.2 Fire Event

In the event a fire impacts an area with radioactive materials, follow the procedures below:

- Pull the fire alarm.
- Follow facility fire safety procedures designed to contain fires and save lives.
- Notify the RSO after vacating area that a fire has occurred involving radioactive material.
- The RSO will advise fire and MBL Campus Security personnel on methods to mitigate potential exposure of employees and emergency responders to radioactive materials, while allowing containment and extinguishing the fire.
- The RSO will maintain, liaison with Fire Department concerning the radiological implications of the fire.

11.3 Off-Hour Emergencies

The Authorized User must approve work with radioactive materials that is not performed during normal working hours prior to beginning the work. In the event of an emergency, contact the MBL Campus Security x7911. The MBL Campus Security will contact the RSO. Remain nearby to direct responding personnel except in situations where evacuation is necessary.

11.4 Theft or Loss of Radioactive Material

In case of theft or other unaccountable losses of radioactive materials, the Authorized User will immediately notify the RSO. The RSO will inform management and conduct a survey of the area. The RSO and Authorized User are responsible for estimating and evaluating the amounts of radioactive material lost based on the current inventory and receipt records. The RSO is also responsible for organizing a survey or search to locate the lost materials. The RSO will make notifications to the Massachusetts Department of Public Health's Radiation Control Program in accordance with the regulatory requirements.

12 RADIOACTIVE WASTE MANAGEMENT

The MBL generates various types of radioactive wastes including liquids, dry active wastes (DAW), mixed wastes (biological and/or chemical) and liquid scintillation media. All radioactive wastes generated from research and teaching activities will be managed by the RSO.

Authorized Users are required to complete and keep accurate records of radioactive materials using the "*Radioactive Material Receipt and Accountability"* form (see appendix). The RSO will provide appropriate radioactive waste containers to Authorized Users. Each radioactive waste container must be clearly labeled to identify the radioisotope, activity, date measured, Authorized User, waste type, and exterior survey results. All radioactivity labels must be defaced or removed from containers and packages prior to disposal in regular (non-radioactive) waste.

All radioactive wastes will be collected from the research and teaching laboratories by the RSO. The MBL maintains a Radioactive Waste Storage Facility, which is always kept securely locked when not in use. An inventory will be created for each radioactive waste container by the RSO. The RSO will manage, track, and coordinate final disposal of radioactive wastes.

Authorize Users should have a goal to reduce or eliminate radioactive waste as much practically feasible to minimize concerns to public and the environment while providing significant cost savings for the MBL.

12.1 Decay-In-Storage (DIS) Guidelines

- The MBL radioactive material license allows the MBL to use Decay-In-Storage (DIS) as a method of waste disposal.
- Radioactive material with a physical half-life of less than 90 days will be included in DIS disposal and shall be held for at least 10 half-lives.
- The primary location for DIS waste is the Radioactive Waste Storage Room in Lillie 8.
- All waste must be properly labeled and identified prior to transfer to the Main Radioactive Waste Storage Room. Ensure the yellow radioactive waste tag is properly completed and attached to container.
- If the container holds mixed waste, a hazardous waste tag identifying the hazardous component (biohazardous or hazardous chemical) must also be attached.
- The estimated disposal date can be estimated as follows: [10 (isotope's half-life in days) + (date received, or date last isotope was added to the container)]. For containers with more than one isotope, the longest half-life is used in this calculation.
- Assign the next consecutive storage number to the container and place identifying number on container. Place container in Decay-In-Storage section of Radioactive Waste Storage Room. Add shielding, if necessary.
- Prior to disposal, perform the following:
    a) Use a survey instrument and method that is appropriate for the type and energy of the radiation being measured. Measure radiation level.
    b) Discard as non-radioactive waste, only those containers that have been held for about 10 half-lives and whose radiation levels at the surface of waste are indistinguishable from background radiation levels.

c) Any containers with radiation levels at the surface that are higher than background radiation levels must be returned to the storage area for further decay or disposed of as Low Level Radioactive Waste (LLRW).
d) Evaluate the non-radioactive waste materials for other hazardous waste materials (hazardous chemicals or biohazardous). If other hazard, ensure those proper disposal procedures are followed.
e) Remove or deface any radioactive material labels prior to discarding the container.
f) Record the disposal date in the storage log for each container. Update the Radioactive Material Inventory Database, as necessary.
g) Create a survey record: container identification number, date the container was put in storage, date of disposal, radionuclide(s) disposed, survey instrument used, background measurement, measurement at the surface of each waste container, and the name of the individual who performed the disposal.
h) The record of each disposal must be kept for three years.

12.2 Low Level Radioactive Waste (LLRW) Guidelines

- Radioactive waste not treated as decay-in-storage must be disposed as LLRW via a commercial vendor or waste broker.
- All waste must be properly labeled with completed Radioactive Waste tag attached to container prior to transfer to the hot laboratory.
- If the container holds mixed waste, attach and complete a red Hazardous Waste tag that identifies the hazardous component.
- Mixed waste must comply with radioactive, hazardous waste regulations, and/or other applicable regulations.
- Biohazardous waste that is radioactive must be made non-infectious by approved methods before being packaged with radioactive waste.
- Complete a Radioactive Waste Container Inventory form upon arrival at the Radioactive Waste Storage Room. Issue the next consecutive storage number to the container or waste tag and complete the rest of the required information. The estimated date of disposal should be N/A. Update the Radioactive Material Inventory database, as necessary.
- Add the following information to the Radioactive Waste tag: storage number and date placed in storage.
- Consolidate waste into appropriate LLRW stream (see below): Dry Active Waste (DAW) for Compaction, DAW Non-Compactable, Liquid Scintillation vials, or Bulk Liquids
- Sealed sources must be stored separately and cannot be combined with the LLRW waste.

Dry Active Waste (DAW) for Compaction

- This type of waste includes solid dry waste (e.g., paper, gloves, personnel protective equipment, cardboard, etc.).
- The waste cannot include liquids that can be poured out, powders, animal carcasses, biohazardous waste, hazardous waste, cylinders, large non-compactable items (e.g. rocks), etc.
- Place the waste in a 55-gallon or 30-gallon steel or poly drum that is lined with 4-6 mil poly drum liner.
- When drum is full, twist and fold over top of bag and j-lock with duct tape. Mark container as DAW Compactable.
- Radionuclides and activity shall not exceed limits for Class A waste.

Dry Active Waste (DAW) Non-Compactable

- This type of waste includes solid dry waste that is non-compactable, such as rocks, contaminated soil, large solid items, etc.
- This type of waste cannot include liquids that can be poured, animal carcasses, biohazardous waste, or hazardous chemical waste.
- Place the waste in a 55-gallon or 30-gallon steel or poly drum that is lined with 4-6 mil poly drum liner.
- When drum is full, twist and fold over top of bag and j-lock with duct tape. Mark the container as DAW Non-Compactable.
- Radionuclides and activity shall not exceed limits for Class A waste.

12.3 Liquid Scintillation Vials

- Place scintillation vial waste in a steel or poly drum that is lined with 4-6 mil poly bags; steel drums are preferred for this waste. No other waste items are permitted.
- Before adding the poly liner to the drum, add enough absorbent to the bottom of drum to account for potential leakage.
- When bag is full, twist and fold over top of bag and j-lock with duct tape.

12.4 Bulk Liquids

- Place liquids into non-leaking containers that are compatible with the waste liquid.
- Place the primary containers in over pack drums. Add sufficient absorbent to the over pack drum such that it can absorb the total volume in the primary waste containers.
- Place incompatible liquids in separate over pack drums.
- Arrange for vendor pickup and disposal of waste, as necessary.
- Update the Radioactive Material Inventory database.

12.5 Uranyl Acetate Waste

Uranyl acetate is regulated differently from other radioactive materials used at the MBL. Any researcher can purchase uranyl acetate directly from the vendor without a radioactive materials license. However, uranyl acetate waste must be disposed of as radioactive waste.

There should be no generation of mixed waste with uranyl acetate without the prior written approval of the RSO. If the laboratory is planning an experiment that could potentially generate mixed wastes, the PI must develop a written standard operating procedure outlining specific procedures for collection, storage, labeling and disposal of mixed waste.

- Place liquid uranyl acetate into non-leaking containers with radioactive waste label. Store liquid and dry uranyl acetate waste in secondary containment in the Radioactive Waste Storage room in Lillie 8.
- For removal, place containers into an over pack drum with ample absorbent that can absorb the total volume in the waste containers. Label drum as Uranyl Acetate.
- Arrange for vendor pickup and disposal of waste, as necessary.

13 RADIATION SAFETY PROGRAM AUDIT

The RSO shall conduct a comprehensive annual audit of the Radiation Safety Program to evaluate whether MBL is adhering to ALARA philosophy and assess general effectiveness of the Program, and to ensure compliance with all regulatory requirements. The annual audit consist of inspecting laboratories where radioactive materials are used or stored, dosimetry records, wipe test survey reports, external radiation survey reports, leak test reports, bioassay reports, training records, instrument calibration records, radioactive material inventory records, and radioactive waste storage areas and records. The RSO summarizes audit findings and provides recommendations in a report submitted to the RSC and MBL senior management.

The audit should also identify Program weaknesses and provide MBL an opportunity to implement appropriate corrective actions. During an audit, the auditor should take into consideration the requirements of the MRCP regulations, MBL's commitment in following regulatory requirements and the conditions of the Radioactive Materials License, and other correspondence with the regulatory agency. The auditor should also evaluate whether MBL is maintaining exposures to workers and the general public *As Low As is Reasonably Achievable* (ALARA) and, if not, make suggestions for improvement.

The *Radiation Safety Program Audit Checklist* form (see appendix), or equivalent form, may be used to document the annual audit of the Radiation Safety Program.

APPENDIX A: Forms

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Radioactive Materials Package Receipt Form……..32

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RADIOACTIVE MATERIAL USE AUTHORIZATION

APPLICATION FOR PERMIT TO USE RADIOACTIVE MATERIALS

The MBL must maintain a permanent record of each individual who uses radioactive materials under the Commonwealth of Massachusetts Radiation Control Program Materials License conditions. This information may be provided to the company that provides radiation exposure personnel monitoring services. You are entitled to receive copies of all of records related to our monitoring of your radiation exposures.

Name: _____ SSN (Last 4 digits): XXX-XX- __
Date of Birth: _____ Arrival Date: _____ Departure Date: _____
Institutional Affiliation for Next Academic Year: _____
Permanent Mailing Address: _____
_____
_____

PREVIOUS EXPERIENCE AND TRAINING

Isotope	Maximum amount used at one time	Where experience was gained	Duration of experience

Have you had formal training in the use of radioactive materials and radiation safety practices?
□ **YES** □ **NO** *If **YES,** provide location and duration of training.*
Location: _____ **Duration:** _____**(Months/Yrs)**

Have you worked with radioisotopes at the MBL in the past? □ **YES** □ **NO**
*If **YES**, provide the date(s)*: _____

Please check the appropriate box and complete information showing your role at the MBL.

	Title / Role	Description		Title / Role	Description
□	Principal Investigator (PI)*		□	Course Director	
□	Associate Scientist		□	Instructor	
□	Other Staff/Student		□	Other Staff	
			□	Student	
Name of PI/CD:			Name of Course:		

I have received, read and understood the MBL Radiation Safety Manual. I agree to abide by the requirements regarding the use of radioactive materials at the MBL.

PRINT NAME: _____ **SIGNATURE:** _____ **DATE:** _____
PRINCIPAL INVESTIGATORS / COURSE DIRECTORS/INSTRUCTORS MUST COMPLETE PAGE 2 OF THIS FORM.

APPLICATION FOR PERMIT TO USE RADIOACTIVE MATERIALS

PRINCIPAL INVESTIGATORS, COURSE DIRECTORS AND INSTRUCTORS who supervise the use of radioactive materials must provide the following information to the Radiation Safety Officer and the MBL Radiation Safety Committee. Prior approval by the MBL Radiation Safety Committee is required for all work involving the use of licensed radioactive materials in MBL.

ISOTOPE(S)	ANTICIPATED TOTAL USAGE (ACIVITY)	MAXIMUM INVENTORY	AMOUNT USED PER EXPERIMENT	CHEMICAL / PHYSICAL FORM

DESCRIPTION OF PROPOSED RESEARCH (*use additional sheet if necessary*).

List locations where you plan to use radioactive materials (Building / Room):

RESEARCH PIs ONLY:

Please list all the personnel you will be working with or supervising while conducting these experiments:

Have you had previous experience conducting such or similar experiments?

□ **YES** □ **NO**

List the Make, Model, and Serial Number of any portable survey meter(s) you have brought to the MBL. *Survey meters are required when research involves the use of gamma emitters or beta emitters with Emax > 0.2 MeV. Survey meters must be calibrated annually.*

SPECIAL RADIATION CONCERNS / ADDITIONAL INFORMATION (if appropriate)

Will radioactive materials be used with animals? □**YES** □**NO**

If yes, please include the Protocol Number from the IACUC.

Will radioactive material be used with any biohazardous materials? □**YES**□ **NO**

If YES, please include name of organism_____ and IBC Protocol #: ____

Will radioactive material be mixed with any hazardous chemicals? □**YES**□ **NO**

If yes, please include the name of the chemical: _____

I have received, read and understood the MBL Radiation Safety Manual. I agree to abide by the requirements regarding the use of radioactive materials at the MBL.

PRINT NAME: _____

SIGNATURE: _____ **DATE:** _____

RADIOACTIVE MATERIALS PACKAGE RECEIPT FORM

This Form must be completed by an individual authorized to directly accept shipment of radioactive materials by the Radiation Safety Committee. Return the completed form and the shipping paper to the Radiation Safety Officer (RSO) at Lillie Room 203 or safety@mbl.edu. Record the following information (all information is required).

Purchase Order Number:	
Vendor:	
Radioisotope:	
Activity Received (µCi):	
Principal Investigator (PI):	
Exposure; CONTACT (R/hr):	
Exposure; I METER (mR/hr):	
Wipe Test (dpm):	
Package Type (LQ; WI; YI; YII):	
Receipt Date:	
Receipt Time:	
Name of Person Receiving:	
Signature:	

1. Exposure is measured with a survey meter equipped with a Geiger-Mueller (GM) pancake probe in a low background area.
2. Record the highest exposure at the surface of the package and at 1 meter (3 feet) from the surface of the package.
3. A wipe test is conducted by wiping a filter paper over a 300 cm^2 (7”x7”) area of the package exterior. Count the wipe test with a liquid scintillation counter.
4. Package Type:
   - **LIMITED QUANTITY (LQ)** has a **UN 2910** label.
   - **WHITE I (WI)** has a white diamond with red “I”.
   - **YELLOW II (YII)** is a yellow and white diamond with red “II”

***Please notify the RSO at (508) 289-7424 immediately if a package appears damaged, leaking, or the wipe test is > 3000 dpm*.**

RADIOACTIVE MATERIAL ACCOUNTABILITY RECORD

1. RECEIVING RECORD

AUTHORIZED USER:	**SIGNATURE:**	**LAB/ROOM:**
ISOTOPE ORDERED:	**COMPOUND:**	**PO NUMBER:**
TOTAL ACTIVITY ORDERED:	**LOT NUMBER:**	**DATE RECEIVED:**

2. PACKAGE CONDITIONS

OUTER PACKAGING MATERIAL CONDITION: □ **GOOD** □ **FAIR** □ **POOR**

PRIMARY VIAL OR SEALS:	□ **Vial Intact**	□ **Vial Broken**	□ **Seals Intact**	□ **Seals Broken**

3. RADIATION READINGS

EXTERNAL EXPOSURE READINGS (mR/hr)	Background	Package Surface	Primary Vial	
REMOVABLE CONTAMINATION	Background	Outer Package	Inside Package	Primary Vial: _____ dpm/100 cm^2

4. REMARKS & SPECIAL CONDITIONS

(a) Always wear disposable gloves when handling radioactive materials (RAM).
(b) Perform contamination surveys on yourself and your work area after each use of RAM.
(c) Eating, drinking & smoking is prohibited in all laboratory and RAM storage areas.

5. ACCOUNTABILITY RECORD

(a) Indicate the **ACTIVITY (*μ*Ci** or **mCi)** of each isotope used from this purchase, name of the authorized user, and the date of that use.
(b) For each entry, indicate how the radioactive waste was disposed.

Date	**Name of User**	**Activity Removed (*μ*Ci/mCi)**	**RADIOACTIVE WASTE DISPOSAL**			
			% Solid (Dry) Waste	**% Liquid Waste**	**% LSC Vial Waste**	**% MIXED/OTHER Waste (describe)**

Upon completion of work, return form to the Radiation Safety Officer. Retain a copy for records.

_____ _____

SIGNATURE OF AUTHORIZED USER **DATE COMPLETED**

Marine Biological Laboratory
THE UNIVERSITY OF CHICAGO

DECLARATION OF PREGNANCY

Name of Employee:	
Department:	
PI/Authorized User (Permit Holder):	

I am officially notifying the MBL Radiation Safety Officer that I am pregnant or trying to become pregnant with an estimated conception date of _____ and an expected delivery date of _____.

I understand the radiation exposure limit set by the Nuclear Regulatory Commission (NRC) for embryo/fetus of the Declared Pregnant Worker is 500 mrem for the entire gestation period. I will continue to minimize my exposure and participate in a monitoring program for pregnant workers.

PLEASE CHECK THE FOLLOWING AS APPROPRIATE:

- ☐ I have questions related to the radiation protection of the embryo/fetus and would like to have the Radiation Safety Officer contact me at _____.
- ☐ I do not wish to inform the Principal Investigator at this time.
- ☐ I have informed or will inform the Principal Investigator.
- ☐ I have questions related to the radiation protection of the embryo/fetus. I will contact the Radiation Safety Officer at 508-289-7424 or safety@mbl.edu.
- ☐ I do not have any questions related to the radiation protection of the embryo/fetus at this time.

_____ _____
RADIATION SAFETY OFFICER Date

_____ _____
DECLARED PREGNANT WORKER Date

RESCINDING PREGNANCY DECLARATION

I, _____, declare that I no longer wish to be considered as a Declared Pregnant Worker.

_____ _____
Signature of Formerly Declared Pregnant Worker Date

Marine Biological Laboratory

THE UNIVERSITY OF CHICAGO

RADIATION SURVEY REPORT

SURVEYOR'S NAME:		**DATE:**	
BUILDING/ROOM #:		**PERMIT HOLDER:**	
Instrument	**Model/Serial #**	**Calibration Date**	**Background**
Hand-Held Meter			
Scintillation Counter			

1. **CONTAMINATION SURVEY (dpm):** Working surfaces and floor areas are **wipe**-tested for removable radioactive contamination in a random fashion. An area of approximately 100 cm^2 is covered by each wipe. Results are reported as net (background corrected) disintegrations per minute (dpm) on the sketch below. Printed results are appended where appropriate.
2. **AREA SURVEY (mrem/hr)**: Radiation dose rates are measured at work areas and storage areas. The readings are reported as millirems per hour (mrem/h) on the sketch below. Except where noted readings are for beta and/or gamma radiation at 1foot. Known sources of external radiation are noted on the sketch.

SAMPLE LOCATION	**Scintillation Counter**			**Hand-Held Meter**
	cpm	**Net dpm**	**Clean/Contaminated**	**cpm**

Marine Biological Laboratory
THE UNIVERSITY OF CHICAGO

RADIOACTIVE WASTE CONTAINER INVENTORY

BUILDING:	**ROOM:**	**AUTHORIZED USER:**
WASTE TYPE:	**□ LIQUID □ DAW (SOLID) □ LSC VIALS □ MIXED/OTHER**	
CONTAINER ID NUMBER:		

DATE ADDED	ISOTOPE	ACTIVITY (µCi)	CHEMICAL FORM	INITIALS

DAW: Dry Active Waste; LSC: Liquid Scintillation Counter

RADIATION SAFETY PROGRAM AUDIT CHECKLIST

AUDIT REPORT NO.: _____ **LICENSE NO.:** _____

Expiration Date: _____
Audit of activities at (Address):

Date of this Audit: _____

Summary of Findings and Action:
[ ] No deficiencies
[ ] Deficiencies
[ ] Action on previous deficiencies

Recommendations:

Auditor: Date: _____

(Signature): _____

AUDIT HISTORY [ ] N/A (N/A means "Not applicable" - Initial Audit)

A. Last audit of this location conducted
B. Problems/deficiencies identified during last two audits or two years, whichever is longer [ ] Y [ ] N
C. Open problems/deficiencies from previous audits:
Status Requirement Prob./Def. Corrective Action Taken [ ] Y [ ] N
Open/Closed _____
D. Any previous problem/deficiency not corrected or repeated [ ] Y [ ] N
Explain:

ORGANIZATION AND SCOPE OF PROGRAM

A. Briefly describe organizational structure
1. Structure is as described in license documents [ ] Y [ ] N
2. Multiple authorized locations of use [ ] Y [ ] N
3. Briefly describe scope of activities involving byproduct material, frequency of use, staff size, etc. [ ] Y [ ] N

B. Radiation Safety Officer
   1. Authorized on license [ ] Y [ ] N
   2. Fulfills duties as RSO [ ] Y [ ] N
C. Use only by authorized individuals [ ] Y [ ] N

Remarks:

TRAINING, RETRAINING, AND INSTRUCTIONS TO WORKERS

A. Instructions to workers [ ] Y [ ] N
B. Training program required [ ] Y [ ] N
C. Training records maintained [ ] Y [ ] N
D. Evaluation of individuals' understanding of procedures and regulations based on interviews, observation of selected workers [ ] Y [ ] N
   1. Each has access to an up-to-date copy of MBL safe use and emergency procedures
   2. Adequate understanding of:
      Current safe use procedures [ ] Y [ ] N
      Emergency procedures [ ] Y [ ] N
E. State Regulations
   Workers cognizant of requirements for:
   1. Radiation Protection Program [ ] Y [ ] N
   2. Annual dose limits [ ] Y [ ] N
   3. Radiological Health Section Forms [ ] Y [ ] N
   4. 10% monitoring threshold [ ] Y [ ] N
   5. Dose limits to embryo/fetus and declared pregnant women [ ] Y [ ] N
   6. Procedures for opening packages [ ] Y [ ] N

Remarks:

INTERNAL AUDITS, REVIEWS, OR INSPECTIONS

A. Audits are conducted [ ] Y [ ] N
   1. Audits conducted by_____
   2. Frequency _____
B. Content and implementation of the Radiation Safety Program reviewed annually [ ] Y [ ] N
C. Records maintained [ ] Y [ ] N

FACILITIES

Facilities as described in license application

Remarks:

MATERIALS

Isotopes, quantities, and use as authorized on license [ ] Y [ ] N

Remarks:

LEAK TESTS

A. Leak tests performed as described in correspondence with the MRCP (consultant, leak test kit, MBL performed) [ ] Y [ ] N
B. Frequency: every 6 months or other interval, as approved by MRCP [ ] Y [ ] N
C. Records with appropriate information maintained [ ] Y [ ] N

Remarks:

INVENTORIES

A. Conducted at 6-month intervals [ ] Y [ ] N
B. Records with appropriate information maintained [ ] Y [ ] N

Remarks:

RADIATION SURVEYS

A. Instruments and Equipment: [ ] Y [ ] N
   1. Appropriate operable survey instrumentation possessed or readily available [ ] Y [ ] N
   2. Calibrated as required [ ] Y [ ] N
   3. Calibration records maintained [ ] Y [ ] N
B. Briefly describe survey requirements:
C. Performed as required [ ] Y [ ] N
   1. Radiation levels within regulatory limits [ ] Y [ ] N
   2. Corrective action taken and documented [ ] Y [ ] N
D. Records maintained [ ] Y [ ] N
E. Protection of members of the public
   1. Adequate surveys made to demonstrate either (a) that the TEDE to the individual likely to receive the highest dose does not exceed 100 mrem in a year, or (b) that if an individual were continuously present in an unrestricted area, the external dose would not exceed 2 mrem in any hour and 50 mrem in a year [ ] Y [ ] N
   2. Unrestricted area radiation levels do not exceed 2 mrem in any one hour [ ] Y [ ] N
   3. Records maintained [ ] Y [ ] N

Remarks:

RECEIPT AND TRANSFER OF RADIOACTIVE MATERIAL (INCLUDES WASTE DISPOSAL)

A. Procedures describe how packages are received and by whom [ ] Y [ ] N
B. Written package opening procedures established and followed [ ] Y [ ] N
C. If package shows evidence of degradation, monitor for
D. contamination and radiation levels [ ] Y [ ] N [ ] N/A
E. Monitoring of degraded packages performed within time specified [ ] Y [ ] N [ ] N/A
F. Transfer(s) between licensees (including “disposal”) performed [ ] Y [ ] N [ ] N/A
G. Records of receipt/transfer maintained [ ] Y [ ] N
H. Transfers within MBL to Authorized Users or locations performed as required [ ] Y [ ] N [ ] N/A
I. Package receipt/distribution activities evaluated for
J. compliance with the MA DPH Radiation Control Program [ ] Y [ ] N [ ] N/A

Remarks:

TRANSPORTATION (49 CFR)

A. MBL shipments are:
   1. Delivered to common carriers [ ] Y [ ] N
   2. Transported in MBL vehicles [ ] Y [ ] N
   3. No shipments since last audit [ ] Y [ ] N
B. Packages [ ] N/A
   1. Authorized packages used [173.415, 173.416(b)] [ ] Y [ ] N [ ] N/A
   2. Closed and sealed during transport [173.475(f)] [ ] Y [ ] N
C. Shipping Papers [ ] N/A
   1. Prepared and used [172.200(a)] [ ] Y [ ] N
   2. Proper Shipping name, Hazard Class, UN Number, Quantity, Package Type, Nuclide, RQ, Radioactive Material, Physical and Chemical Form, Activity, Category of label, TI, Shipper’s Name, Certification and Signature, and Emergency Response Phone Number [172.200-204] [ ] Y [ ] N
   3. Readily accessible during transport [177.718(e)] [ ] Y [ ] N
D. Vehicles [ ] Y [ ] N
   1. Cargo blocked and braced [177.842(d)] [ ] Y [ ] N
   2. Placarded, if needed [172.504] [ ] Y [ ] N
   3. Proper over packs, if used (shipping name, UN Number, labeled, statement indicating that inner package complies with specification package) [173.25] [ ] Y [ ] N
E. Any incidents reported to DOT [171.15, 171.16] [ ] Y [ ] N

Remarks:

PERSONNEL RADIATION PROTECTION

A. ALARA considerations are incorporated into the Radiation Safety Program [ ] Y [ ] N
B. Adequate documentation of determination that unmonitored occupationally individuals are not likely to receive >10% of allowable limit [ ] Y [ ] N [ ] N/A
   OR
C. External dosimetry provided and required [ ] Y [ ] N [ ] N/A
   1. Supplier Frequency
   2. Supplier is NVLAP-approved [ ] Y [ ] N
   3. Dosimeters exchanged at required frequency [ ] Y [ ] N
D. Occupational intake monitored and assessed [ ] Y [ ] N [ ] N/A
E. Reports [ ] N/A
   1. Reviewed by Frequency
   2. Auditor reviewed personnel monitoring records for period
   3. Prior dose determined for individuals likely to receive doses [ ] Y [ ] N
   4. Maximum exposures TEDE
   5. NRC Forms or equivalent
      (a) NRC Form 4: "Cumulative Exposure Record History" [ ] Y [ ] N
      Complete: [ ] Y [ ] N
      (b) NRC Form 5: "Occupational Exposure Record for a Monitoring Period" or equivalent [ ] Y [ ] N
      Complete: [ ] Y [ ] N
      (c) Worker declared her pregnancy in writing during inspection period (review records) [ ] Y [ ] N [ ] N/A
      If yes, determine compliance with [ ] Y [ ] N
      Check for records [ ] Y [ ] N
F. Records of exposures, surveys, monitoring, and evaluations maintained [ ] Y [ ] N

Remarks:

AUDITOR'S INDEPENDENT MEASUREMENTS (IF MADE)

A. Survey instrument Serial No. last calibration
B. Auditor's measurements compared to Radiation Safety's [ ] Y [ ] N
C. Describe the type, location, and results of measurements:

NOTIFICATION AND REPORTS [ ] N/A

A. In compliance with reports to individuals, public and occupational, monitored to show compliance [ ] Y [ ] N [ ] N/A
B. In compliance with theft or loss regulations [ ] Y [ ] N [ ] None
C. In compliance with incidents regulations [ ] Y [ ] N [ ] None
D. In compliance with overexposures and high radiation levels [ ] Y [ ] N [ ] None
E. Aware of emergency telephone numbers [ ] Y [ ] N

POSTING AND LABELING

A. "Notice to Workers" is posted [ ] Y [ ] N
B. License documents are posted, or a notice indicating where documents can be examined is posted [ ] Y [ ] N
C. Other posting and labeling [ ] Y [ ] N

Remarks:

RECORD KEEPING FOR DECOMMISSIONING (if needed) [ ] N/A

A. Records of information important to the safe and effective decommissioning of the facility maintained in an independent and identifiable location until license termination [ ] Y [ ] N
B. Records include all information [ ] Y [ ] N

Remarks:

BULLETINS AND INFORMATION NOTICES

C. Receipt of Bulletins, Information Notices, Newsletters, etc. [ ] Y [ ] N
D. Appropriate action taken in response to Bulletins, Information
E. Notices, etc. [ ] Y [ ] N

Remarks:

SPECIAL LICENSE CONDITIONS OR ISSUES [ ] N/A

A. Review special license conditions or other issues, and describe findings:
B. Problems/deficiencies identified at MBL facilities other than at audit location:
C. Evaluation of compliance:

CONTINUATION OF REPORT ITEMS [ ] N/A

(If more space is needed, use separate sheets and attach to report.)

PROBLEMS OR DEFICIENCIES NOTED; RECOMMENDATIONS [ ] N/A

Note: Briefly state (1) the requirement and (2) how and when violated. Provide recommendations for improvement.

EVALUATION OF OTHER FACTORS

A. Senior MBL management is appropriately involved with the Radiation Safety Program and/or Radiation Safety Officer (RSO) oversight [ ] Y [ ] N
B. RSO has sufficient time to perform his/her radiation safety duties and is not too busy with other assignments [ ] Y [ ] N
C. MBL has sufficient radiation safety staff [ ] Y [ ] N

Remarks/Recommendations