Boston University/ Boston Medical Center

Radioisotope Use Manual

August 2015
Revision 2

BOSTON UNIVERSITY / BOSTON MEDICAL CENTER

Radioisotope Use Manual

August 2015

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Emergency Contact Information

Medical Physics and Radiation Safety (617) 638-7052

Incident Type	CRC	BU/BMC
HAZARDOUS MATERIALS SPILL Chemical, Biological, And Radioactive	**(617) 353-2105**	**(617) 414-6666**
PUBLIC SAFETY INCIDENT (CODE GREEN) Immediate response to a suspicious person, altercation, theft, etc.	**(617) 353-2121**	**(617) 414-4444**
OCCUPATIONAL HEALTH business hour numbers	**(617) 353-6630**	**(617) 638-8400**
RESEARCH OCCUPATIONAL HEALTH PROGRAM injuries occurring in laboratories	**(617) 414-7647**	**(617) 414-7647**
ENVIRONMENTAL HEALTH AND SAFETY	**(617) 353-4094**	**(617) 638-8830**

PREFACE

This Radiation Safety Manual contains the policies, regulations, and recommended procedures for the safe use of radiation sources at Boston University and Boston Medical Center (BU/BMC). It is incorporated as a condition in the radioactive material license issued to BU/BMC by the Massachusetts Department of Public Health, Radiation Control Program (DPH RCP) and must be adhered to by all radiation users. Although overall responsibility for radiation safety rests with the university and hospital, basic responsibility for the protection of life and property must be assumed by the authorized users, permit holders, and individual user of radiation sources. Thus, an individual desiring to use radioactive materials or radiation generating devices must possess acceptable qualifications and follow designated policies and procedures as outlined in this guide.

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BOSTON UNIVERSITY

Statement of Commitment to Environmental Health and Safety

Boston University is committed to maintaining a healthy and safe environment for its students, faculty staff, visitors, and neighbors and to fostering a culture of safety among users of all campus facilities. Members of the Boston University community should therefore comply with all environmental health and safety laws and regulations and with current best practices, especially in laboratory settings. In addition, members of the community should commit to continuous improvement in their efforts to minimize adverse environmental impacts and safety risks and to supporting a culture of safety in the University's operations by:

- Accepting the critical role each person has in protecting his or her own safety as well as that of others.
- Recognizing the critical importance of adherence to the highest standards for safety and occupational health for our students, our staff, and the communities around us.
- Minimizing air and water pollution and waste generation.
- Incorporating safety as an integral aspect of all operations, including but not limited to experimental design, facility construction, and equipment specifications.
- Providing students and employees with safety education targeted to maximize safe work practices and to minimize the potential for injury or illness.
- Creating an environment where individuals are able to recognize and to report errors without fear of reprimand or punishment.
- Providing appropriate and timely information in response to questions or concerns about environmental health and safety issues.
- Investigating incidents, disseminating lessons learned in such reviews, and modifying programs, as appropriate, to incorporate any potential improvements identified.
- Creating an environment of collaboration among all stakeholder, including researchers, safety specialists, students, and staff from facilities management and public safety, to identify safety issues and to find solutions to safety problems.

The University's Environmental Health and Safety staff, working closely with oversight committees, has developed policies and procedures designed to further the above goals.

Deans, directors, department heads, managers and other supervisors at the University are responsible for implementing this commitment within their areas of responsibility. I ask every member of the Boston University community to cooperate in these important matters.

Robert A. Brown

January 2012

Introduction

Section 1

The use of radioactive materials and radiation generating devices is strictly regulated by Federal, state and local agencies to ensure the safety of the radiation workers and the public. It is important for all individuals within BU/BMC who use radioactive materials or radiation generating devices to read and abide by the rules documented within this guide.

Radioactive materials and radiation emitting devices (referred to herein as "radiation sources") are valuable tools used in areas as diverse as medicine, biology, chemistry, engineering, and physics. Yet, if used improperly, they have the potential of being hazardous to us or our environment. Therefore, individuals using radiation sources must understand the hazards and precautions associated with these sources and are required to comply with relevant Federal, state, local and institutional radiation safety regulations and standard practices.

Radiation sources at Boston University and Boston Medical Center (BU/BMC) are regulated by the Massachusetts DPH RCP. Through this agency, BU/BMC has been granted a broad scope license to manage its use of radiation in Boston University laboratories and at the Boston Medical Center. This license offers the institutions the necessary degree of flexibility and autonomy to purchase, use, store, and dispose of radioactive materials, in settings of research and the diagnosis and treatment of patients. As part of the requirements of our broad scope license, BU/BMC is required to appoint a Radiation Safety Committee (RSC) and a Radiation Safety Officer (RSO) to oversee the radiation safety program. This program is subject to periodic audits by the DPH RCP to verify our regulatory compliance and to ensure the safety of personnel and members of the public.

This Radiation Safety Manual describes the organization of the RSC and the Division of Medical Physics and Radiation Safety (DMPRS) in the Office of Environmental Health and Safety (EHS) and presents the requirements applicable to all users of radioactive material. This manual is consistent with the applicable Federal and state regulations and is in accordance with the requirements of our institutional license. Since compliance with the above license does not in itself ensure a safe program, additional rules and procedures have been specified in this manual to enhance our Radiation Safety Program.

How to Use This Manual

Radioactive materials are used at BU/BMC for human and non-human research purposes. Radioactive materials are also routinely used at Boston Medical Center for diagnostic and therapeutic clinical purposes. For obvious reasons, the requirements for the use of radioactive materials for non-human research are very different from those for clinical purposes. This manual describes the process that researchers and health care workers must follow when using radioactive materials in each of their respective settings.

The process described in this manual includes:

- Applying for the use of radioactive materials,
- Prerequisite skills and experience needed for the primary investigator or health care worker,
- Setting up the facilities for radioactive material storage and use,
- Procedures for the use and monitoring to ensure a safe work environment, and
- Responsibilities of the permit holder (PH) and all other involved personnel in maintaining radioactive material use privileges.

Appendices provide forms, procedures, and other general information for users in implementing their responsibilities as a radiation worker at Boston University and Boston Medical Center.

Section 2

ALARA Policy

Boston University and Boston Medical Center are committed to maintaining exposures As Low as Reasonably Achievable (ALARA). Although current occupational radiation exposure limits provide a very low risk of injury, it is prudent to practice radiation safety techniques and protocols to minimize unnecessary exposures.

The object of an ALARA program is to "reduce occupational exposures as far below the specified limits as is reasonably achievable by means of good radiation protection planning and practice, as well as a management commitment to policies that foster vigilance against departures from good practice." (USNRC Reg. Guide 8.l0)

The ALARA program at BU/BMC consists of the following elements:

A. Training: A radiation safety training program is provided by Environmental Health and Safety through its Division of Medical Physics and Radiation Safety. The goal of this program is to allow those individuals who may come in contact with radioactive materials or radiation generating equipment to recognize and protect themselves from sources of radiation.

B. Dosimetry: A comprehensive program of dosimetry services including badge monitoring and bioassays is provided by the Medical Physics and Radiation Safety Division. The division will investigate any radiation exposures greater than 10% of the regulatory limits listed in Table 1, Section 5 of this guide and will ensure future exposures are maintained ALARA.

C. Radiation Surveys: A radiation survey program is used to check each area where radiation sources are used. Laboratories are checked to ensure proper techniques are used during procedures involving radiation sources.

D. Safety Reviews: The RSO and the RSC reviews and must approve all uses of radioactive materials. In addition, the RSO and RSC annually audit the radiation safety program to verify compliance with Federal and state regulations and BU/ BMC policies and procedures. The RSO may require authorized users to demonstrate how well their project meets the ALARA principles.

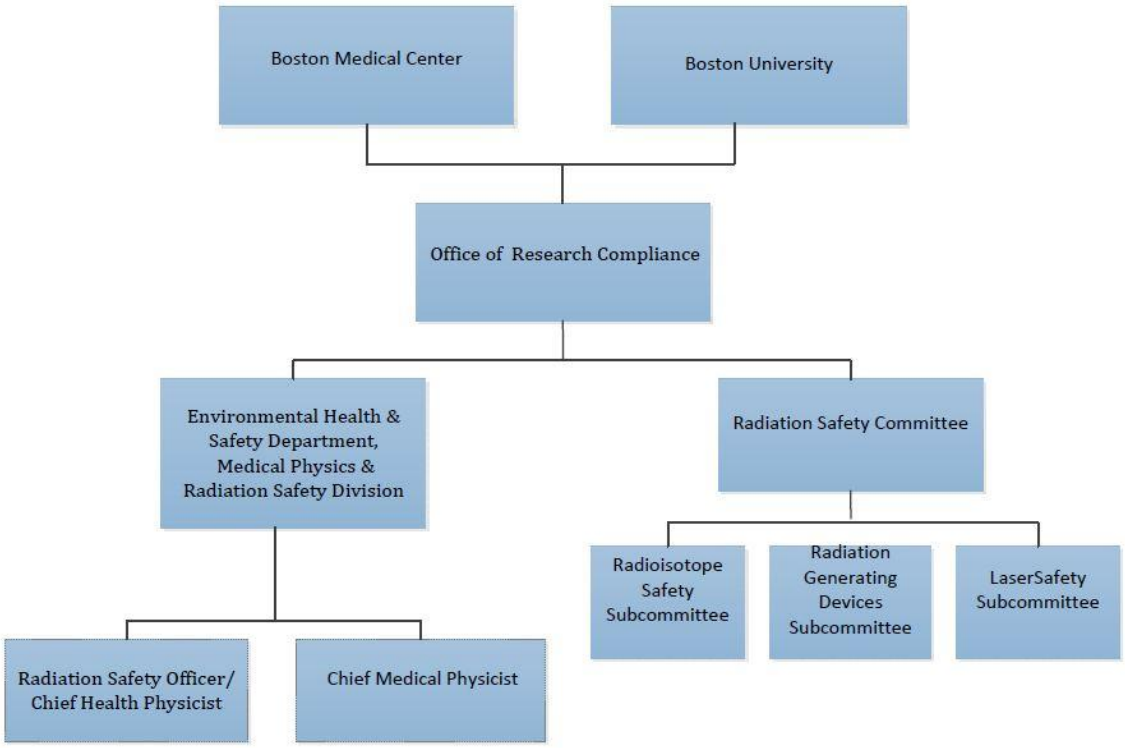
Section 3

Organization, Authority and Responsibility

The Radiation Safety Program applies to the use of radioactive materials and radiation generating devices at Boston University and Boston Medical Center. Although the program spans across two institutions with separate management structures, both institutions are represented on the Radiation Safety Committee, which jointly oversees radiation safety.

The organization, authority, and responsibility for the Radiation Safety Program are presented in figure below:

Figure 1: Organizational Chart of the Boston University and Boston Medical Center Radiation Safety Program



Executive management

Executive Management of BU/BMC has the ultimate responsibility for the Radiation Safety Program.

Radiation Safety Committee (RSC)

Radiation Safety Committee Charter

The RSC Charter (Appendix I) is a written document that describes the role and responsibilities of the RSC for the two institutions. The Charter also describes how members of the committee are appointed and the length of their term of service.

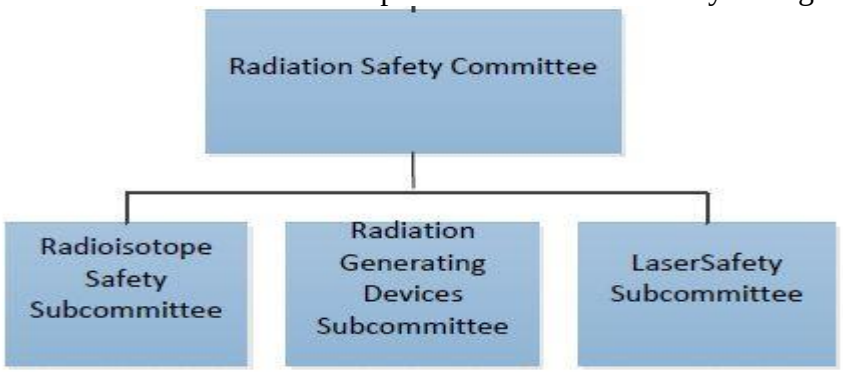
Membership

The members of the Committees are appointed by Boston University and Boston Medical Center, and are selected to represent broad areas or divisions within the campuses of individuals who use radiation sources. Committee charter describes committee composition, responsibilities, function, and appointment process

Committee Responsibilities, Delegation of Authority, and Subcommittees

The RSC is responsible for assuring that an adequate safety program is developed and implemented within the university and communicates radiation safety policy, regulations, and procedures. The RSC is also responsible for ensuring that radiation exposure to workers and patients are managed according to all applicable regulations and best healthcare practices. The RSC may delegate its authority to various persons, ad hoc subcommittees, and standing subcommittees. To ensure good communication between programs and to verify that activities are carried out according to established policies and procedures, the Director of the DMPRS shall be a permanent member of the RSC and all other related committees and subcommittees.

The RSC shall also ensure that an annual review or audit of the radiation safety program is conducted. There are three standing subcommittees that perform reviews of permit applications, incidents, Institutional Review Board (IRB) submittals, and the status of management systems. The three subcommittees and their relationship to the RSC are shown by the figure below.



Committee and Subcommittee Meetings

The RSC and its subcommittees hold quarterly meetings. All subcommittees must meet prior to the quarterly meeting of the RSC. Each subcommittee will provide members of the RSC with a quarterly status report for the programs they are responsible for overseeing. Minutes of meetings will be recorded and kept on file for review by committee members, regulatory agencies, and BU/BMC Management.

Please see Appendix I: Radiation Safety Committee Charter for more information about how the committee and subcommittees carry out their responsibilities.

The Division of Medical Physics and Radiation Safety

The EHS Division of Medical Physics and Radiation Safety (DMPRS) is responsible for assuring compliance with relevant Federal, state, local and Institutional regulations and enforces policies established by the RSC. The DMPRS maintains a staff to assure the safe receipt, use, storage, and disposal of radioactive materials and is authorized to intervene to prevent hazardous conditions from developing or to eliminate existing unsafe conditions on any matter related to radiation safety.

> *In this capacity, the DMPRS staff is granted the authority to immediately stop workers from performing radiation related activities they determine are inconsistent with accepted radiation safety standards and practices and that pose an imminent threat to the health and safety of personnel or the public.*

Such stoppages may be enforced for no more than forty-eight hours without the expressed approval of either the RSO, or the Chairman of the RSC or, in their absence, their designee. Members of the DMPRS have the right to petition the RSC to suspend workers or permit holders from using radioactive materials or radiation producing devices if these individuals or laboratories have been identified as exhibiting a history of non-compliance with institutional, state, or Federal rules and regulations. The Director of Medical Physics and Radiation Safety reserves the right to revoke a staff member's enforcement authority in the event that a staff member is found to abuse this policy.

The DMPRS is managed by the Director of Medical Physics and Radiation Safety. The Director oversees the daily affairs of the medical physics and radiation safety program.

The RSO is responsible for developing and maintaining the radioisotope radiation safety program within the limits set forth by Federal and state regulations. This program contains the policies and procedures relating to the safe use of radiation sources at BU/BMC and is distributed in the form of this Radiation Safety Manual.

Section 4

Permitting for Radioactive Material Use

The institution must ensure that all individuals who use ionizing and non-ionizing radiation sources are aware of the regulatory requirements. Therefore, BU/BMC has agreed on a process for issuing permits to individual researchers and clinicians for the possession and use of such materials and devices and have entrusted the Radiation Safety Committee with reviewing and issuing the permits. This section lists the materials and devices that will require a permit, and describes the process for applying.

Devices and Isotopes Requiring a Permit

Permits are required for the devices and isotopes listed below so that the RSC can ensure that all applicable state regulations are implemented. Permits are required for the following:

1. Radioactive Isotopes (Human and non-human use)
    a. Technically enhanced naturally occurring radioisotopes (such as radium)
    b. Radioactive material generated by an accelerator
    c. Radioactive material generated as a byproduct of nuclear fission
    d. Compounds containing uranium
    e. Compounds containing thorium
2. Analytical X-ray devices
3. Industrial X ray devices
4. Lasers (Class III-b and IV only) *

*Permits for lasers and analytical X-rays devices are managed under separate programs and manuals. This manual only applies to the use, storage and disposal of radioactive materials.

Applying for a Radioisotope Permit

Individuals applying for a permit must be on staff within BU/BMC. In certain cases technically qualified individuals from outside either of these institutions may be given a temporary use authorization to carry out a relatively long-term or repetitive experiment. Such authorizations are governed by the same requirements as any other permit holder.

Becoming a Permit Holder

Individuals are designated as a permit holder (PH) by the RSC after careful consideration of their training and experience with radiation sources or devices for which they are applying. The ongoing responsibilities of the permit holder depend on whether the permit is for the use of radioisotopes or for radiation devices. The reason for the difference is due to the requirements mandated by the institution's Radioactive Material License issued by the Massachusetts Radiation Control Program. The license requires demonstrating ongoing compliance through

periodic radiation surveys, recordkeeping, etc., and the institutions place responsibility for many of the required day-to-day activities on the permit holder.

All research permit applications must include a Curriculum Vitae (CV) or resume, written preceptor statement and other requested documentation. All applications may be obtained from EHS website. Once the application is determined to be complete by the DMPRS, it will be submitted to and reviewed by the appropriate subcommittee. The RSO or Director of DMPRS may provide temporary approval of permits prior to review by the RSC.

Application for Radioisotope Use Permit - Non-Human Use

1. The applicant must have a Faculty/staff position within BU/BMC and have a minimum of a Master of Science degree.

2. Applicant has completed all Radiation training and other requirements.

3. Applicants must provide documentation from their previous employer that they have a minimum of 6 months of radiation work experience using similar radionuclides and quantities being applied for. Otherwise, the applicant must work under the supervision of an existing permit holder using similar radionuclides and quantities for a minimum of 6 months before the application will be acted upon by the RSC.

4. The individual must be familiar with the requirements of this manual and have made adequate provisions for radiation safety and control within their lab.

5. The individual must be able to secure the appropriate facilities and equipment to safely conduct activities.

6. The individual must receive written authorization from the RSC, the RSO or his designee.

7. The use of radiation sources by undergraduate students for educational purposes will be under the direct supervision of a PH or approved researcher after prior approval by the DMPRS. The Permit Holder must request permission to use radioisotopes with students. Each request is handled on a case by case basis. The Permit Holder is required to submit a safety plan as part of their request which upon approval by DMPRS will ensure that no student's exposure will exceed 10 mrem.

Application for Radioisotope Use Permit - Human Use

The use of radioisotopes in humans requires both an active Radioisotope Permit issued by RSC and specific clinical privilege granted by the Trustees of BMC after review of qualifications by the Credentialing Committee. Radiation sources used for diagnostic and therapeutic procedures such as in Nuclear Medicine, Endocrinology, Radiation Medicine, etc., can only be performed under the direct supervision of a trained physician. Physicians requesting “authorized user”

status must meet the applicable requirements specified in 105 CMR 120.500 and must be approved by the RSC. In some therapeutic uses the services of a qualified medical physicist may also be required.

Radioactive material involved in clinical trials must be used under the direct supervision of an approved permit holder with the approved clinical privileges and through a protocol approved by the IRB and the Radioisotope subcommittee.

Responsibilities of a Permit Holder

Permit holders (PH) are responsible for implementing radiation safety rules, regulations, and procedures and are directly responsible for the following laboratory safety issues:

1. The PH is responsible for the safety of each person under the PH's permit.
2. The PH is also responsible for assuring compliance with BU/BMC, state, and Federal rules and regulations regarding radioactive materials or radiation emitting devices.
3. The PH must verify that radioactive materials and radiation devices are properly purchased, stored, used, and disposed.
4. The PH must assure that appropriate records documenting the safe use of radioactive material and radiation emitting devices are maintained and available for review. These records include but are not limited to:

    a. Requests to procure, use, or dispose of radioactive material or radiation producing devices,
    b. Area contamination reports,
    c. Documentation of final disposition of radioactive sources,
    d. Memos documenting radiation related issues within the laboratory.

5. Permit holders are responsible for having their staff trained in site-specific radiation safety procedures and techniques. This is in addition to the introductory radiation safety training provided by the DMPRS

Permit Status

Permits may be considered either active, suspended or inactive.

A permit holder's status may change from active to inactive or suspended by one of four methods:

1. The RSO will evaluate the status of all permit holders annually, and those who have not used or ordered radioactivity in one calendar year will be contacted. If their future use of radioactive materials is unknown or known to be not at all, they may change their status to inactive by removing all radioactive materials, radioactively contaminated items and objects, and waste. Removal of all radioactive materials and contamination will be verified by RSO. Their status will then be changed to inactive.

2. The permit holder may request to change their permit status to inactive but maintain their permit for grant purposes. Their request will be handled by RSO as in No. 1 above.
3. The RSO may change a permit holder's status to inactive due to other circumstances as considered appropriate after conditions in No. 1 above have been satisfied.
4. RSC may change a permit holder status to "suspended" if biennial training is not completed. Reinstatement of PH status to "active" will require completion of Basic Radiation Safety Training.

Suspended Status

Permit holders status may become suspended if training requirements for the permit holder and/or users listed on the permit do not complete required training. Once training has been completed, the DMPRS will confirm that training has been completed and reinstitute active status.

Inactive Status

Inactive use permit holders and individual users of radioactive materials whom they supervise must maintain all the conditions of their permit including biennial refresher training. Laboratories that apply or are designated for inactive status must meet the following requirements:

1. Inactive laboratories cannot possess radioactive material. All radioactive waste, samples, contaminated items, etc. must be properly removed and/or disposed of and disposition verified by the DMPRS.
2. A survey for "Release for Unrestricted Use" must be performed by the DMPRS and the change in use status approved by the RSO.
3. The ordering or transfer of radioactive material to a laboratory designated inactive must be approved by the DMPRS and the laboratory will be re-designated as an active laboratory. In that regard, all labeling, posting, surveying, recordkeeping, etc. pertaining to an active status laboratory are applicable.
4. Inactive Use permit holders will be considered to possess a permit solely for grant purposes only. Inactive permit holders will not be required to perform the recordkeeping, surveys, inspections and other duties associated with possessing radioactive materials. Additionally, the RSO will not perform inspections of inactive permit holders until the status changes, but will maintain cognizance of their status.
5. Inactive permit holders and authorized users are required to perform biennial refresher training.

Laboratory Supervisors

In many instances, the permit holder will not always be available to provide direct supervision of radioactive material users. Therefore, the permit holder may designate a Laboratory Supervisor to act on their behalf. The ultimate responsibility for the use of radioactive materials, however, remains with the permit holder. The Laboratory Supervisor will be identified on the permit as the permit holder's designee.

Authorized Users

Persons working under a permit holder must follow the policies and procedures as outlined in this manual. They must use radiation sources only under the supervision of the permit holder and in the manner specified in the application for authorization to use such sources. Before working with radiation sources a radiation worker must have received introductory radiation protection training by a member of the DMPRS and must receive on site laboratory training by the laboratory permit holder or his/her designee. The authorized user must read the laboratory permit prior to beginning work.

Becoming an Authorized User for Radioisotopes

1. Individuals who must work with radiation sources are required to complete introductory radiation safety training offered by the DMPRS. The training schedule and sign up are available in RIMS.

   The goal of basic radiation protection training is to familiarize the radiation worker with the following:

   - Basic radiation science.
   - Radiation risk, biological effects, protection, and safety.
   - The concept of ALARA (As Low As Reasonably Achievable).
   - Federal, state, and university rules and regulations.
   - The responsibilities of the authorized user, permit holder, and the BU/BMC radiation safety program.
   - Basic laboratory safety procedures.
   - Emergency response procedures.

2. Before the radiation worker is allowed to handle radioactive material or operate a radiation emitting device, the worker must undergo site specific safety training by the permit holder or designee.
3. Laboratory workers not specifically handling or working with radiation sources will receive radiation hazard awareness training as part of the introductory laboratory safety training that all workers receive upon hire.
4. Clinical use of radioisotopes requires obtaining clinical privileges which are granted by Trustees of BMC.

Responsibilities of an Authorized User

Any individual at BU/BMC who works in an area where radiation sources or devices are used or stored is considered an authorized user. Authorized users at BU/BMC are responsible for:

1. Participating in basic radiation safety training provided by the DMPRS prior to entering the designated radiation work site.

2. Being trained by the laboratory's permit holder (or designee) on specific radiation safety practices within the laboratory.
3. Following the BU/BMC ALARA program by keeping his/her radiation exposure As Low As Reasonable Achievable in addition to keeping his/her radiation exposure levels below the state and Federal limits presented in Table 1 (section 5).
4. If appropriate, wearing radiation monitoring devices such as film badges, ring badges, pocket ion chambers.
5. Using standard laboratory protective measures when working with radioactive material. Such measures include (but are not limited to):

    a. Wearing appropriate protective clothing (note: shorts and open toe shoes are not appropriate clothing).
    b. Using appropriate radiation shielding
    c. When possible and practical, use mechanical devices or remote handling tools to reduce radiation exposure to the extremities.
    d. Whenever practical, minimizing the amount of time the worker is exposed to radiation and performing experiments in an efficient, expeditious manner.
    e. Performing work in an approved hood or glove box if it is possible that radioactive material may be released into the air.

6. Ensuring that no eating, drinking, smoking, or applying cosmetics or lotions occur in areas where radioactive materials are present. It is against regulations to store food or beverages in a laboratory.
7. Maintaining good work habits and safe laboratory techniques as specified in Appendix II (Radiation Laboratory Rules and Regulations).
8. Performing a radiation survey (see Appendix VIII: Guide for Performing Radiation Surveys)
    a. At the end of each day when radioactive materials have been used/accessed.
    b. Following the transfer of radioactive materials from stock solutions.
    c. After each experimental run if there is a possibility of a change in radiation levels or contamination.
9. Immediately cleaning up contaminated areas and reporting spills and skin contamination to the DMPRS as soon as possible (See Emergency Contact information)
10. Keeping the laboratory neat and organized.
11. Labeling and isolating radioactive sources, waste, and radiation emitting equipment.
12. Understanding how to procure/purchase radioactive materials as described in Section 6.
13. Being familiar with the safe use and storage of radiation emitting materials and devices as described in Section 7.
14. Properly storing and disposing of radioactive waste as described in Section 8.
15. Contacting a permit holder or a member of the DMPRS if you are unsure of a radiation safety related issue.

Radioisotope Permit Deficiencies

Permit holder must correct all deficiencies in laboratory identified by the DMPRS within two weeks of notification. If a corrective action cannot be completed within a two-week timeframe the reason must be communicated to the RSO with an estimated time to completion.

If a lab has two citations within six months, the entire lab must be retrained (including PH); if another citation occurs within the subsequent six months, ordering will be suspended until all are retrained again.

Reauthorization

Authorized users must be reauthorized by the RSC on a biennial basis. Permit holders will be notified two months prior to the expiration date of their permit, and the PH must make arrangements and ensure that all individuals whom they supervise attend any necessary training such as the mandatory biennial radiation safety refresher training for radioisotope users. Permit holders who do not satisfy the biennial refresher training within two months past their renewal date will be prevented from purchasing radioactive materials, the permit will be deemed suspended and all radioactive work must stop until training is completed. In some instances the DMPRS may confiscate all radioactive materials. After 90 days, the permit holder will need to reapply for a new radioisotope permit with retraining of all users.

Individuals (users that are non-permit holders) must satisfy the biennial refresher training requirement prior to renewal.

Section 5

Radiation Safety Regulations and Policies

This section describes fundamental regulations, policies, and procedures for the use of radioactive materials. These Federal and state regulations are legally binding and require the maintenance of certain records and the fulfillment of certain obligations by all authorized users. Failure to meet these legal requirements could place our state license in jeopardy, and failure to comply with established policies and procedures could compromise radiation safety.

Federal Regulations

The Nuclear Regulatory Commission has established regulations to control the use and licensing of radioactive materials and nuclear facilities. The principle regulations on which this guide is based are provided in Title 10 Code of Federal Regulations Part 20 (10 CFR 20), entitled, "Standards for Protection against Radiation."

State Regulations

The Commonwealth of Massachusetts specified its own rules and regulations for the control of radioactive material and radiation producing devices in code regulation 105 Code of Massachusetts Regulations 120 (105 CMR120). These standards are similar to those found in l0 CFR 20 of the Federal Regulations. Radiation users must comply with the applicable requirements of both state and Federal regulations.

University and Hospital Policies and Procedures

Boston University and Boston Medical Center (BU/BMC), as licensees for the possession and use of radiation sources, recognizes its responsibility to the Commonwealth of Massachusetts to establish appropriate policies and procedures for the safe use of radiation sources. To this end both institutions appointed the RSC (See Appendix I: Radiation Safety Committee Charter) to develop such policies and procedures. This committee is directly responsible to the Executive Management of BU/BMC in all matters of radiation safety as previously discussed.

The Committee has established in this Radiation Safety Manual the policies and regulations to be followed by all users at BU/ BMC. Any additions or modification of procedures remain the responsibility of the RSC. Changes will occur as revisions or additions to this guide become necessary for purposes of clarification, changes in title or positions, and other reasons which in no way shall result in a lessening of the safe use of radiation sources and devices.

Definition of a Radiation Source

A radiation source is any radionuclide, X-ray machine, accelerator or other device capable of emitting hazardous ionizing radiation(s) and is subject to the provisions of this guide. Hazardous ionizing radiation is any particulate or electromagnetic radiation capable of producing biological damage through the ionization of an atom.

Occupational Radiation Exposure Limits

BU/BMC workers shall conform to the safety limits specified in Massachusetts regulation 105 CMR 120 regarding the total radiation exposure allowable in one calendar year. Here, a person's radiation exposure is referred to as the total effective dose equivalent (TEDE), as the total external and internal doses to an individual, and given in units of rem (a formal definition of TEDE is provided in 10 CFR 20.1003). Often times, a radiation exposure is small enough to be given in terms of millirem (mrem) where 1,000 mrem is equal to 1 rem. Table 1 presents a summary of the maximum radiation exposures (in units of rem/year) that a radiation worker is allowed to receive in a single calendar year. While the exposures in Table 1 present the legal limit that a radiation worker may receive, The University strictly adheres to the ALARA principle requiring users to minimize their radiation exposures. (SEE ALARA, Section 2).

Table 1: Occupational Effective Dose Equivalents Limits (rem/year)

Total Effective Dose Equivalent (body)	5
Dose to Lens of the eye	15
Dose to Extremities and Organs	50
Dose to Embryo (Declared Pregnancy)	0.5/term

Administratively, the above limits are controlled by limiting the total effective dose equivalent to l00 mrem/month. Exemptions to this administrative limit may be granted by the RSO or his/her designee for specific projects on an as needed basis. Radiation sources normally encountered in the various activities at BU/BMC are not expected to cause doses above this administrative limit. In fact, exposures are expected to be well below this limit. In addition, members of the public are limited to no more than 0.1 rem/year from radiation related activities performed at BU/BMC.

Regulations Regarding the Control of Radiation Sources

To maintain public safety and meet relevant state and Federal regulations, all radiation sources are controlled for the lifetime of the source. The BU/BMC Radiation Safety Program therefore has set up the following controls:

1. Any laboratory in which radiation sources are to be used or stored must first be authorized by the RSC for such tasks and must have a permit holder to accept responsibility for implementing the requirements of this manual.

2. Ordering and purchasing radiation sources are controlled through the DMPRS. Individuals wishing to purchase a radiation source should review Section 6.

3. The use or storage of radiation sources within a laboratory must meet the conditions and standards of this manual. Section 7 of this manual presents the requirements for storing and using radiation sources.

4. The final disposition of a radiation source (shipping, or waste handling) shall meet the requirements of Section 8 of this manual.

Section 6

Purchase of Radioactive Materials and Devices

A mutually convenient arrangement between the Purchasing Office and the DMPRS has been established to prevent the accidental purchase and use of radioactive material by persons not familiar with the requirements of this Radiation Safety Manual. All purchases are coordinated by the DMPRS.

Purchasing

All radioactive material and device purchases must first be approved by the laboratory's permit holder or designee and then approved by the DMPRS as described in this section. Only active status permit holder can order radioisotopes.

All radioactive material purchase requests must be submitted on-line to the DMPRS. Accounting information included in the submission must be accurate and current. The DMPRS staff member will review the order and ensure the permit holder is active, the isotope may be possessed by the permit holder, and the amount requested is within their allowed possession limit. The DMPRS staff member places all orders of radioactive material directly with the vendor.

Package Receipt

When a radioactive material package is shipped to the BU/BMC the DMPRS will receive, open, inventory, and process the radioactive materials shipment. After processing, a member of the DMPRS will deliver the package to the laboratory.

Radioactive materials ordered for clinical purposes may be delivered by a carrier directly to the location in which they will be stored and used. The receiving department, such as Nuclear Medicine or Radiation Oncology, is responsible for receiving and opening the package according to the established procedures. The receiving department is also responsible for performing the necessary surveys, documenting the results of the surveys, and providing the initial response if a package is found to possess contamination. In this regard, departments receiving a package that exceeds 22 dpm/cm^2 for a beta gamma emitter, or 2.2 dpm/cm^2 for an alpha emitter, or whose transport index exceeds 10 millirem per hour at a distance of one meter must be placed in a safe isolated location and contact the DMPRS immediately.

The DMPRS will check all radioactive material packages it receives for contamination and verify that external dose rates agree with the values stated by the shipper. It is therefore not required for a laboratory to perform a radiation survey on a package received from the DMPRS but it is advisable to verify contamination levels or radiation field levels under the following conditions:

- *The package is damaged or its integrity compromised after receipt from the DMPRS*
- *The radioactive material container is visibly damaged*

All packages containing non-clinical solutions of radioactive material (liquid, solid, gaseous) should be entered onto a Radioisotope Use Log (see Form DMPRS 1). This form may be used as documentation for radioactive material inventory. Users should use this form to document each time that the radioactive material is removed and dispensed from the isotope stock container.

Section 7

Working with Radioactive Materials and Devices

Personnel using radioactive material must ensure that the location in which the material is used, and the equipment that may become contaminated during use, is strictly controlled. This section provides the guidance necessary to ensure such control is maintained.

Storage of Radioactive Material and Devices

All radiation sources must be stored in a secure location (restricted access, minimum fire hazard, approved ventilation, sufficient shielding, and locked), labeled, and the location posted with a "Caution Radioactive Material" or “Caution Radiation Emitting Device” sign. The DMPRS will provide the laboratory with the proper signs and documentation to ensure compliance with the posting requirements of 105 CMR 120.

Inventory

To maintain proper control of radiation sources and to meet our regulatory requirements it is necessary for a radiation laboratory to keep an inventory of all its radiation sources. This inventory shall include the following information:

1. Source description,
2. Original activity or radiation emission rate and date,
3. Current activity (date of inventory),
4. Physical location,
5. Disposition of material and date

Inventory form the DMPRS 1 is recommended for recording the above information and may be obtained from the DMPRS.

Labeling

Each individual radiation source (or container, if appropriate) shall be labeled with an identification tag clearly indicating the date, radionuclide, volume, and activity. Labels are available from the DMPRS. All tags or labels must be removed / replaced when the information on them is no longer applicable. Radioactive materials meeting the exemption criteria of 105 CMR 129.297 do not need to be labeled. Call the DMPRS for questions on the labeling of radiation sources.

Personnel Radiation Monitoring (Dosimetry)

Regulations require the licensee to provide radiation dosimetry to any individual that may exceed ten percent of the applicable annual occupational dose limit. (See Section 5) Operations in the laboratory and hospital were evaluated for the potential to exceed ten percent of the dose limit.

Operations that require dosimeter badge were identified and the wearing of dosimeter by these individuals is considered mandatory. Operations that do not require the wearing of dosimeter were also identified, and the wearing of dosimetry by these individuals is considered "optional," i.e., the individual may participate in the dosimetry program and can elect to wear a dosimeter if they so choose and must fully cooperate with the periodic change out of the dosimeter. Any changes to an individual's status with the program will be communicated with the individual.

Laboratory Operations

Under most circumstances individuals working at BU/BMC will not require the use of radiation dosimetry but may be provided dosimetry under specific circumstances. The most frequently used radioisotopes in the laboratory include low to medium energy beta emitters. These radioisotopes cannot produce exposure levels sufficient to result in radiation dose to individuals even approaching ten percent of the applicable dose limit; the radiation is primarily slowed down and absorbed in air before reaching the individual.

The most significant source of radiation exposure to individuals working in the laboratory would be in the form of skin contamination. Radiation dosimeters are not designed or intended to monitor skin contamination. The potential for skin contamination is monitored through real-time surveys using radiation detection meters and wipe testing.

Hospital Operations

Individuals working directly with radiation sources, such as nuclear medicine isotopes, fluoroscopy, radiography, etc. do have the potential for approaching and exceeding ten percent of the applicable occupational dose limits. Therefore, individuals working directly with radiation sources in the hospital environment will require radiation dosimetry. Hospital employees that may inadvertently be exposed to radiation, such as through incidental contact with patients injected with nuclear medicine isotopes or standing in the vicinity while a portable X-ray machine is used, receive very little exposure and do not require monitoring for radiation exposure. These individuals may be provided with dosimetry. That being said, there may be special cases when such individuals will require radiation monitoring. The DMPRS maintains awareness of radiation source use and will evaluate the need for monitoring for special cases.

Contamination Control

Radioactive contamination control is practiced through the proper handling of radioactive material, use of adequate protective clothing, and use of sealed containers for transfer and storage of such material. The following steps will help to control the creation and spread of contamination:

1. All areas in which contamination is detected or anticipated will be posted as a "Radioactive Material Use" area.
2. Required protective clothing will be specified and provided to radiation workers.
3. Swipe tests will be taken to evaluate the level of contamination.
4. Volatile radioactive compounds will be stored in sealed containers and vented prior to use in approved filtered hoods.
5. Smoking, eating and drinking will be prohibited in experiment work areas and contaminated areas.

6. Air samples will be taken if significant airborne contamination is anticipated.
7. Leak tests will be performed on sealed sources.

Controlled Areas

Controlled areas will be established for controlling movement of radiation sources and personnel. Segregating these areas will minimize the potential for accidental contamination and unnecessary radiation exposure. Every individual working or visiting such areas should observe signs and directions indicating actions to be taken in a specified area.

The controlled areas are designated as follows:

1. A controlled area is an area where access is controlled for purposes of personnel protection. State and Federal regulations place the following restrictions on elevated radiation areas:

   a. Radiation Area: A radiation area is defined as any area, accessible to personnel, in which radiation levels could result in an individual receiving a dose equivalent in excess of 5 millirem at a distance of 30 cm in one hour from a radiation source. These areas must be posted.

   b. High Radiation Area: This area is defined as any area, accessible to personnel when radiation levels could result in individuals receiving a dose equivalent in excess of 100 millirem in one hour at 30 cm from the radiation source or boundary. High Radiation Areas require access control measures to be instituted as prescribed in l0 CFR 20.l60l.

2. Contamination Area -- an area where controlled access is maintained for the purpose of contamination control. Persons should not enter such an area without authorization and proper personnel protection. The following defines a contamination area:

Type of Radiation	Removable Contamination Limits (dpm/100 cm^2)
Beta (except tritium)	500
Tritium	1,000
Gamma	2,000
(Nuclear Medicine)	(20,000 restricted area)
	(2,000 unrestricted area)

Radiation Monitoring

Routine radiation and contamination monitoring surveys are conducted by the DMPRS as part of good radiation safety practice and to ensure compliance with our license requirements.

Surveys shall include a contamination survey and, if appropriate, an area radiation survey. Laboratories which use radioisotopes which do not pose an external radiation hazard (such as C-

14 or H-3) are not required to perform radiation area surveys but are required to perform contamination surveys. Radiation workers who wish to review proper radiation survey techniques may consult Appendix VIII of this manual or may contact a member of the DMPRS.

The following is a list of *required* laboratory radiation surveys:

1. Radiation and contamination surveys (as applicable) when a radioisotope is used and especially immediately following the transfer of radioactive materials from stock solutions.

2. After each experimental run if there is a possibility of a change in radiation levels or contamination.

3. After a radioactive material spill.

Survey Frequency

Frequency of laboratory surveys will depend on the status of the radioisotope permit and hazards classification of the isotopes used and possession limits as outlined in the table below.

		Hazard classification			
		Low	Medium	High	Very High
Possession/ Use in one month	<0.1 mCi	Semi annual	Quarterly	Monthly	Weekly
	0.1-1 mCi	Semi annual	Quarterly	Monthly	Weekly
	1-10 mCi	Quarterly	Monthly	Weekly	Daily
	>10 mCi	Monthly	Weekly	Daily	Daily

Isotope (unsealed)	Hazard classification	Hazard class based on
H-3	Low	Internal
C-14	Medium	Skin dose
I-125	High	Internal
P-32	High	Skin dose
P-33	Medium	Skin dose
S-35	Medium	Skin dose
Cr-51	Medium	External
Ca-45	Medium	Skin dose
Nuclear Medicine*	High	Internal

*Survey frequency dictated by regulation.

Storage and Security of Radioactive Material

Radionuclides must be stored only in designated storage areas/containers, which are approved by the DMPRS. These areas and containers must be secured when unattended in a manner which prevents access and/or removal by unauthorized and untrained personnel. In practice, if the access to laboratory or storage is limited only to authorized users (no ancillary or clerical staff has access), it is considered a sufficient security measure. If this is not possible, secure and lockable security freezers are acceptable. If neither of the previously mentioned security measures is available, affixed security boxes are a widely used solution throughout BU/BMC. The security of irradiators is addressed in Public Safety procedures and policies.

Posting Of Radioisotope Storage and Use Areas

Proper hazard communication is an integral part of the radiation safety program. All entry ways to spaces permitted to use radioactive materials will display a small radioactive materials sign on the posted BU HAZCOM sign. In addition, all entry ways will have emergency contact numbers visible detailing the DMPRS contact information during business hours and Control Center contact information for 24hr support.

Signs and labels are available from the DMPRS and must only be used to correctly communicate presence of the radioactive material, radiation hazards, or airborne radioactive contamination.

Depending on the nature of the area or laboratory the sign must bear the words:

- **Caution Radioactive Material** - This sign is required in areas where radioactive materials are used or stored.

Records

It is a legal requirement of our state radioactive material license that certain records be maintained and made available to the licensing agency. In accordance with this requirement and as part of good radiation safety program, the RSC requires that the following information be recorded:

1. The permit holder shall:
    a. Keep an inventory of radiation sources (Form DMPRS 1) and waste disposals (Form DMPRS 5),

2. The DMPRS shall maintain:
    a. Up-to-date inventories of all radiation sources,
    b. Radiation surveys and monitoring records of a general and special nature,

c. Records of all incidents (spills, releases, contamination problems) involving radiation sources,
d. Leak test data on all radiation sources,
e. Personnel monitoring records,
f. Instrument calibration records,
g. Waste disposal records,
h. Licensing data,
i. Emergency equipment lists,
j. Minutes of RSC and subcommittee meetings,
k. Applications for authorization to use radiation sources,
l. Copies of authorizations and a list of all Authorized Users,
m. Decommissioning files in accordance with state regulations.

Release of Areas and Equipment for Unrestricted Use

Areas and equipment associated with the storage, use and disposal of radioactive materials that will be released for unrestricted use must meet the following:

1. All radioactive material containers (including waste containers) must be removed.
2. All equipment associated with the processing, handling and storing of radioactive material must be surveyed on all accessible surface areas to ensure radioactive materials are below the limits defined in Appendix IX.
3. Equipment that has the potential to become internally contaminated must be either surveyed to verify absence of radioactivity, or be disposed of as radioactively contaminated. Special consideration must be given for plumbing, air handling, and fume hoods.

Section 8

Radioactive Waste Management and Disposition of Radioactive Materials and Devices

The transfer of radioactive material, whether in sample form, as waste, or as an unused compound, to another permit holder within the institution or to an organization outside the institution is subject to licensing and transportation regulations. No transfer may take place between campus, within the same campus, or off campus unless it is approved by the DMPRS.

Shipping

Transportation of radioactive materials is regulated by the Massachusetts DPH, U.S. Nuclear Regulatory Commission, U. S. Department of Transportation (DOT), and the U.S. Postal Service. These regulations require that the university maintain a central inventory of all radiation sources. Therefore, all radiation source shipments must be approved and documented by the DMPRS.

Radioactive materials may be transferred only to another authorized user, either at the University or another institution when preapproved by the DMPRS and as specified in the authorized users permit. Only Radiation Safety Personnel may transfer radiological sources and products between buildings or campuses. If the transfer is to another institution, allow enough time for the DMPRS to work with the other institution's Radiation Safety Organization and complete the appropriate paperwork.

Radioactive Waste

BU/BMC are required under state law to store all radioactive waste in approved containers using approved handling techniques and to maintain written records regarding the storage and disposal of radioactive waste. *It is a violation of Federal, state, and University regulations to dispose of radioactive waste as normal trash*. The DMPRS must be contacted immediately (617-638-7052) if it is found that radioactive waste is or has been disposed of improperly or if laboratory personnel are unsure of proper (approved) waste handling/disposal techniques.

A. General Radioactive Waste Handling Rules Applicable to All Radioactive Waste

1. Radioactive waste is required to be segregated by isotope
   NOTE: The laboratory may combine ^{3}H and ^{14}C into a single container or may combine short half-life ($T_{1/2} \leq 120$ days) materials together. In all cases, materials added to a waste container shall be chemically non-reactive with both the container and its contents.

2. All radioactive waste shall be separated and stored into the following physical forms:
   - Solid waste,
   - Liquid waste,

- Sharps waste,
- Animal carcasses,
- Lead (Pb) shipping containers.

Detailed instructions on proper radioactive waste storage and handling for each physical waste form (also referred to as a "waste stream") are described below.

3. Environmental Management is available to assist in finding vendors of approved radioactive waste containers.

4. Regardless of the *type* of radioactive waste generated, <u>all</u> radioactive waste shall be assembled in designated restricted areas and stored in waste containers clearly labeled with the following: *"RADIOACTIVE WASTE"* or *"CAUTION RADIOACTIVE MATERIAL."* Environmental Management will not accept radioactive waste stored in improper waste containers.

5. Radioactive chemicals or powders, contaminated sharps, and radioactive animal carcasses are examples of a "mixed waste stream." All such waste shall meet the requirements for radioactive material waste handling as documented in this procedure ***<u>and</u>*** the requirements for chemical/hazardous material waste handling as documented by EHS's Environmental Management division. Lead containers must not be placed in radioactive waste containers. Keep lead containers in a separate storage bin for pick up by Environmental Management.

6. *Laboratories shall maintain a list containing the isotope and total activity present within each waste container generated or used by that laboratory*. It is the responsibility of the permit holder to assure that this list is promptly and accurately maintained.

7. Radioactive labels must be removed or defaced prior to placing in radioactive waste container.

8. When in use, a radioactive waste container shall be labeled with the following information:
    a. "RADIOACTIVE WASTE" or "CAUTION, RADIOACTIVE MATERIAL" warning sign;
    b. Listing of the radioisotope(s) present within the container;
    c. One entry for each time waste is added to the container;
    d. Chemical form(s) of the radioisotope(s) present (if liquid).

9. When full, a radioactive waste container shall be labeled with the following information:
    a. Listing of the radioisotope(s) present within the container;
    b. Estimate of the activity present of each radioisotope (preferably in mCi);
    c. Chemical form(s) of the radioisotope(s) present;
    d. Authorized user's name;
    e. Laboratory room number;
    f. Name of person labeling the waste;
    g. Date that the waste was labeled.

10. All radioactive waste receptacles shall be kept in an approved area within the laboratory - not in the hall or other unsecured area. It is the responsibility of the permit holder to verify that the location of the waste receptacle within the laboratory does not present a health hazard.

11. When a radioactive waste container is full, submit a "Waste Pick-Up Request" using the online form on the EHS website.
    NOTE: Environmental Management will not accept possession of any waste containing contaminated glass *unless* it is stored in a plastic lined rigid container (plastic, cardboard).

12. It is the responsibility of the permit holder to verify that the waste is properly contained and identified. Environmental Management has the right to refuse waste pickup for improperly stored waste. The permit holder also is responsible for ensuring that any improperly stored waste (especially waste refused for pickup) is properly repackaged *as soon as possible*.

    Short-lived waste may NOT be stored for decay (i.e., until the activity of the waste is indistinguishable from background) in the laboratory. The City of Boston Fire Department requirements preclude the storage of such waste in the laboratory for the purpose of decay in storage. The Fire Department has permitted a specific area for this purpose.

B. Solid Waste Handling Rules

1. On the bench top, solid (dry) radioactive waste (gloves, absorbent material, etc) shall be stored in clear Plexiglas containers lined with clear plastic bag. All labels indicating radioactivity must be defaced prior to placing in the waste bin.

2. Bags from the bench top containers may be consolidated into larger containers; however, the containers must be the yellow 5 gallon pails available from Environmental Management (at no charge).

3. Each radioactive waste container (bench top or floor pail) shall be identified with the magenta and yellow radiation symbol and the words: "RADIOACTIVE WASTE" or "CAUTION RADIOACTIVE MATERIAL."

4. Radioactive solid waste is required to be segregated by isotope.
   NOTE: The laboratory may combine ^{3}H and ^{14}C into a single container or may combine short half-life ($T_{1/2} \leq 120$ days, i.e. P-32, S-35, Tc-99m, and I-131) materials together. In all cases, materials added to a waste container shall be chemically non-reactive with both the container and its contents.

5. *The laboratory shall maintain a list of the isotope(s) and total activity present within each container*. It is the responsibility of the permit holder to assure that this list is promptly and accurately maintained.

6. While in use, each radioactive waste container shall be clearly labeled with the information required above. Verify that this information is not obscured from view.

7. Radioactive waste placed in containers shall NOT include any liquids, animal tissue, animal excreta, blood products, lead (Pb), or loose sharp objects likely to cause a laceration or puncture wound.

8. Radioactive material must not be put into a waste container if there is the possibility of a chemical reaction during storage that may cause a fire, explosion, or the release of radioactive material.

9. Special care must be taken in storing radioactive waste containing volatile isotopes such as iodine and some forms of Sulfur-35. It is suggested that these wastes be double bagged and tightly sealed. Charcoal felt must be used to assist with the control of iodine volatility. Please call Environmental Management (x88830) if you have any questions on this matter.

10. When the container is full, the waste shall be labeled to clearly display the information required in Part A: General Radioactive Waste Handling, Bullet 8. Verify that the label is not obscured from view.

11. After labeling a full waste container, submit a "Request for Waste Pickup" using the online form provided on the EHS website.
    NOTE: Environmental Management will not accept possession of any waste containing contaminated glass *unless* it is stored in a plastic lined rigid container (plastic, cardboard).

C. Liquid Waste Handling Rules

1. Liquid radioactive waste (including liquid scintillation fluid) shall be contained in plastic or glass, sealable jugs. Call Environmental Management (617-638-8830) if special consideration must be given to another type of container due to chemical incompatibility with approved plastic or glass containers.
    NOTE: Liquid radioactive waste should be doubly protected. Plastic storage bins are therefore available from Environmental Management Office.

2. Each radioactive liquid waste container shall be identified with the magenta and yellow radiation symbol and the words: "RADIOACTIVE WASTE."

3. Radioactive waste is required to be segregated by <u>isotope</u>.
    NOTE: The laboratory may combine ^{3}H and ^{14}C into a single container or may combine short half-life (typically $T_{1/2} \leq 90$ days, i.e. P-32, S-35, Tc-99m, and I-131) materials together. In all cases, materials added to a waste container shall be chemically non-reactive with both the container and its contents.

4. While in use, each liquid waste container shall be clearly labeled with the information required in Part A: General Radioactive Waste Handling, Bullet 7. Verify this information is not obscured from view.

5. The laboratory shall maintain a list of the isotope and total activity present within each container. It is the responsibility of the permit holder to assure that this list is promptly and accurately maintained.

6. When the liquid radioactive waste container is nearly full, attach a Radioactive Material Tag to the container including the information documented in Part A: General Radioactive Waste Handling, Bullet 8. Verify that the label is not obscured from view.

7. Submit a Request for Waste Pickup using the online form provided on the EHS website.

8. Organic based Liquid Scintillation cocktails containing ^{3}H or ^{14}C at concentrations below 0.05 μCi/ml (1.11×10^{5} dpm/ml) are disposed of as toxic waste <u>without</u> regard to radioactivity (that is, it is considered non-radioactive).

9. Disposal of *aqueous* liquids via a designated radioisotope laboratory sink may be performed <u>only</u> if the laboratory meets the following criteria:

    a. The waste is an aqueous solution <u>AND</u>
    b. The isotope concentration falls within the limits documented in Appendix XII: Forms, DMPRS 4: BU/BMC Sink Disposal Limits of Radioisotopes, <u>AND,</u>
    c. The permit holder has been previously approved by the EHS for sink release for the specific chemical in question.

10. The permit holder is responsible for maintaining records which document the total activity disposed via the sink disposal route, the isotope disposed, and the date.

D. Animal Carcass Waste Handling Rules

1. All animal carcasses shall first be placed in a plastic bag and then in a brown paper biohazard material bag (e.g. a Kraft bag). Animal carcass, animal tissue/parts, and animal excreta/bedding may be placed together in the same bag for the same animal.

2. Animal carcass waste bags shall **<u>NOT</u>** contain:
    a. Needles
    b. Syringes
    c. Knives
    d. Blades
    e. Glass
    f. Sharps
    g. Scalpels
    h. Pipettes
    i. Ceramics.

3. Once the animal carcass has been double bagged, it must be frozen for at least twenty four prior to pick up by Environmental Management. Environmental Management will provide

the container for the animal carcasses to ensure compatibility with the waste vendor acceptance criteria.

4. A radioactive material tag (or sticker) must be placed on the outermost bag and must be fully labeled as described in Part A: General Radioactive Waste Handling, Bullet 8.

5. Submit an online request using the EHS website to arrange a pickup.

E. Sharps Waste Handling Rules

1. All sharps (needles, syringes, razor blades, scalpel blades, microtome blades, microscope slides/covers, pipette tips, Pasteur pipettes, broken glass, or any object likely to cause a laceration or puncture wound) contaminated with radioactive material shall be deposited into a special sharps container.

2. Radioactive sharps waste is required to be segregated by <u>isotope.</u>
   NOTE: The laboratory may combine ^{3}H and ^{14}C into a single container or may combine short half-life (typically $T_{1/2} \leq 90$ days) materials together. In all cases, materials added to a waste container shall be chemically non-reactive with both the container and its contents.

3. Each radioactive sharps waste box shall be identified with the magenta and yellow radiation symbol and the words: "RADIOACTIVE WASTE."

4. While in use, each sharps waste container shall be clearly labeled with the information required in Part A: General Radioactive Waste Handling, Bullet 8. Verify this information is not obscured from view.

5. The laboratory shall maintain a list of the isotope and total activity present within each container. It is the responsibility of the authorized user to assure that this list is promptly and accurately maintained.

6. When the sharps radioactive waste container is full, attach a Radioactive Material Tag to the container including the information documented in the Part A: General Radioactive Waste Handling, Bullet 8. Verify that the label is not obscured from view.

7. Submit an online request using the EHS website to arrange a pickup.

F. Lead Shipping Containers

Many stock vials are shipped from vendors within lead (Pb) shielded containers. These containers shall be disposed of by Environmental Management. Non-contaminated lead shields may be disposed of as per the rules and regulations documented by the Boston University Environmental Health and Safety Office. Any lead shield contaminated with radioactive material shall be either labeled and stored as radioactive waste or labeled and given to the DMPRS.

APPENDICES

Appendix I: Radiation Safety Committee Charter

Appendix II: Radiation Laboratory Rules and Regulations

Appendix III: Radiation Detecting and Counting Instrumentation

Appendix IV: Guide for Using Portable Survey Meters

Appendix V: Radiation Accident Response

Appendix VI: Permit Holder Responsibilities

Appendix VII: Research Authorized User Responsibilities

Appendix VIII: Guide for Performing Radiation Surveys

Appendix IX: BU/BMC CONTAMINATION ACTION LIMITS FOR RELEASE

Appendix X: DPH Notice To Employees

Appendix XI: BU Radioisotope Posting

Appendix XII: Forms

Appendix I: RSC Charter

Boston University and Boston Medical Center
Radiation Safety Committee Charter

Purpose and Scope

Radiation sources that produce ionizing and non-ionizing radiation are used extensively throughout the Boston University (BU) and Boston Medical Center (BMC). Radiation sources have the potential to cause serious physical harm to patients, members of the general public and workers. Depending on the setting, certain radiation sources (e.g., radioactive materials, linear accelerators, etc.) are strictly regulated by Federal and State agencies and are subject to periodic inspections by the oversight agencies. Other radiation sources (e.g., nuclear magnetic resonance, microwaves, etc.) are regulated more broadly and are not subjected to the same degree of rigorous regulatory oversight. BU and BMC have established a consistent framework for the oversight and control of the possession and use of all radiation sources to ensure the safety of patients and the public, and to provide a safe and healthful workplace for all BU employees.

This charter establishes a single governing body, the Radiation Safety Committee (RSC), which will have overall oversight of the possession, use, and disposal of all ionizing and non-ionizing radiation sources used for research, clinical, instructional and service purposes within the University, the hospital and its affiliates. The establishment of a RSC to oversee all uses of radioactive materials is required by the BU and BMC Material License issued by the Massachusetts Department of Public Health (DPH) Radiation Control Program.

In this process all users of radiation devices are simultaneously committed to ensuring that all uses are in compliance with federal and state regulatory requirements, the specific conditions of the license issued to BU and BMC, and that any resulting radiation exposures are "as low as is reasonably achievable (ALARA)."

The RSC shall develop and recommend comprehensive polices and guidelines for the safe use of all sources of radiation including all clinical and research uses of radioactive materials, ionizing and non-ionizing radiation generating devices. The RSC shall provide general review and audit of radiation safety programs at BU and BMC to determine compliance with regulations and licenses issued on the local, state and federal levels. The RSC shall establish minimum initial and ongoing training requirements for users of radiation sources. The RSC shall also review, approve, disapprove and require changes in order to grant approval for any ionizing and non-ionizing radiation use in order to comply with regulations and to meet reasonable standards of safety and health.

The directives of the RSC will be carried out by Radiation Safety staff with support of the Technical Committees. Directives specific to regulatory compliance will be carried out based on modality by the appropriate subject expert: Chief Medical Physicist / Diagnostic Imaging, Radiation Safety Officer (RSO), Radiofrequency Safety Officer, or Laser Safety

Officer with the assistance from other Division of Medical Physics and Radiation Safety (DMPRS) staff members. Technical Committees, Medical Physics and Radiation Safety services are provided by the Office of Research Compliance reporting to the Associate Vice President of Research Compliance who has broad responsibilities for research safety and compliance oversight at Boston University and Boston Medical Center.

Committee Membership

The RSC will be composed of the Chair of the Radiation Safety Committee who may be one of the representatives from the various groups that use radiation sources: two representatives from each of the RSC subcommittees (radioisotopes, radiation-generating devices and laser) will be selected from among users of radioisotopes, radiation generating machines, lasers, ultrasound, etc. plus two members with specific expertise in radiation protection. The RSC must also have a nursing representative and a senior management representative from BMC and from Boston University. The two members with specific expertise in radiation safety shall be the RSO and the Chief Medical Physicist for Diagnostic Imaging. The Director of the Division of Medical Physics and Radiation Safety will be a voting member of the RSC and shall, with the Manager of Technical Committees, coordinate the efforts of the RSC subcommittees as detailed by the RSC recommendations. The Associate Vice President for Research Compliance will provide a list of potential Committee candidates to the BMC Senior Vice President of Medical Affairs & Chief Medical Officer, the Provost of the BU Medical Campus and the BU Vice President & Associate Provost for Research, who will all review, modify and approve the final Committee membership prior to their appointment by the Associate Vice President for Research Compliance.

Committee Terms

The terms on the committee for the RSO, Chief Medical Physicist for Diagnostic Imaging, and Director of the Division of Medical Physics and Radiation Safety are indefinite. All other terms, including the committee chair, will be for two years with reappointments being determined by the Associate Vice President for Research Compliance with input from the respective institutional leadership.

Executive Committee

The RSC Executive Committee is composed of the RSC chair, the Radiation Safety Officer, the Chief Medical Physicist for Diagnostic Imaging and the Director of the Division of Medical Physics and Radiation Safety.

Subcommittees

The Committee may establish RSC subcommittees to perform specific functions. The subcommittees will function to fulfill the charge of the RSC in an area of expertise (Radioisotopes, Radiation Generating Devices and Laser). Each subcommittee shall submit a written report of its activities and actions to the Committee for each calendar

quarter in which it is active. Any authority granted to a subcommittee is subject to approval for action by the full committee. Each subcommittee report accepted by the committee becomes part of the record retained with the Technical Committees and Medical Physics and Radiation Safety Division files. Each subcommittee will be composed of a chair and committee members who are subject matter experts in that area of radiation. The subcommittees may enlist the assistance of outside consultants or other BU staff as appropriate provided any compensation is agreed upon by the RSC Executive Committee and Senior Management Representatives.

Technical Committees, under the direction of the Technical Committees' Manager, will provide support to and facilitate all committee activities, coordinate cross-committee communication, membership appointments, and track progress of committee's and subcommittee's charge obligations in support of the Committee and Sub-Committee Chairs.
DMPRS will provide technical support and recommendations on implementation and regulatory compliance of committee's directives - coordinated by the Director of DMPRS.

Committee Charge

The committee shall:

- Ensure that ionizing and non-ionizing radiation sources are used safely. This includes review as necessary of training programs, equipment, facilities, supplies, procedures and reports;
- Ensure that ionizing and non-ionizing radiation sources are used in compliance with regulations, the institutional license, BU specific requirements and generally accepted standards;
- Establish acceptable credentials, training and refresher training, for those requesting authorized user status;
- Ensure that the use of ionizing and non-ionizing radiation sources is consistent with the ALARA philosophy and program;
- Establish a table of investigational levels for individual occupational radiation exposures; and
- Identify program problems and solutions.

Committee Responsibilities

The committee shall:

- Review the training and experience of proposed clinical authorized users, and radioisotope, laser, analytical, and industrial x-ray permit holders.
- Document in writing the training of physicians, podiatrists, nurses, and mid-level care providers who intend to operate x-ray fluoroscopy equipment.

- Review all requests for authorization to use ionizing radiation sources within the institution on the basis of safety, limitations of the regulations, the license, and the ALARA philosophy.

- Approve all policies and radiation safety program changes prior to sending to the relevant agency for licensing action.

- Receive, review and develop corrective actions for, all incidents involving radiation sources regardless of whether the incident is reportable to an external agency. This includes all deviations from the intended use, equipment malfunctions, overexposures, and patient-related errors.

- Review quarterly the occupational radiation exposure records of all personnel, giving attention to individuals or groups of workers whose occupational exposure appears excessive.

- Review at least annually the entire radiation safety program to determine that all activities are being conducted safely and in compliance with the regulatory requirements.

- Recommend remedial action to correct any deficiencies identified in the radiation safety program.

- Maintain written minutes of all committee meetings, including members in attendance and members absent, discussions, actions, recommendations, decisions, and numerical results of all votes taken.

Frequency of Meetings

The RSC meets at least quarterly at a time arranged by the chair for attendance of the maximum number of members. Additional meetings may be called if circumstances dictate need. Subcommittees will meet quarterly prior to the RSC quarterly meeting. The agenda of the RSC and subcommittees are determined by the chair of these committees with support of representatives of Technical Committees and Medical Physics and Radiation. The minutes of the meetings are recorded by a representative of the Technical Committees group and distributed by email for revision and approval following each meeting. The quarterly subcommittee minutes are reviewed and approved at the quarterly RSC meeting. These minutes are permanently retained in case needed for review by regulatory agencies.

Quorum Requirements

A quorum of the RSC shall constitute 50% + 1 of the existing membership. The quorum must include the chair, the Director of Medical Physics and Radiation Safety Division, the RSO, the Chief Medical Physicist for Diagnostic Imaging, at least one senior management representative, and the nursing representative or their alternate. There is no quorum requirement for subcommittees.

Committee Reporting

Recommendations and minutes of the RSC meetings are sent to the Associate Vice President for Research Compliance and the BMC Quality, Safety and Patient Experience Council. All recommendations, comments or questions in the minutes regarding a specific project or program are sent to the person in charge of that project and to the person having administrative authority for the department involved when such action appears appropriate. Permanent copies of the minutes of RSC meetings shall be retained by the RSO.

Relationship of the Radiation Safety Committee and the Radiation Responsible Officials:

BU and BMC has four Radiation Responsible Officials (RRO). The RROs are the:

- Radiation Safety Officer (RSO)
- Chief Medical Physicist / Diagnostic Imaging (CMP)
- Laser Safety Officer (LSO)
- Radio Frequency Safety Officer (RFSO)

Each RRO is responsible for keeping the RSC and the Director of Medical Physics and Radiation Safety Division apprised of all major actions taken to implement and ensure compliance with radiation safety rules and regulations on campus. Each RRO shall implement and ensure compliance with the directives of the RSC and coordinate the total radiation safety program to ensure proper and timely response to current problems. The RROs shall also maintain oversight of the:

- Renewal and changes in any federal, state, or other licenses, registrations or other authorizing documents obtained and held by Boston University or Boston Medical Center that pertain to the use of radiation or radioactive materials.
- Any other important records that may be required or deemed appropriate.
- ALARA program.

RSC Committee Collaboration with other Committees

The RSC will collaborate with other committees within BU and BMC as needed. Other committees include, but are not limited to:

- Laboratory Safety Committee
- Institutional Biosafety Committee
- Institutional Animal Care and Use Committee
- Institutional Review Board
- Credentialing Committee

Metrics to evaluate RSC effectiveness

1. Number and severity of radiation related Incidents Investigated

2. Number and severity of radiation related regulatory inspection results and findings, if any.
3. Number of ALARA exposure reports Reviewed/Investigated
4. Number of IRB reviews and approvals
5. Regulatory and BMC/BU policy compliance rates for quality control testing, preventative maintenance, and/or calibration of:
    a. Radiation generating devices (x-ray, MRI, ultrasound, Roof-top RF transmit antennas)
    b. Radiation protection apparel (e.g., lead aprons, etc.)
    c. Radiation detection equipment
    d. Nuclear medicine imaging equipment
6. Regulatory and BMC/BU policy compliance rates for radiation safety training
7. Regulatory and BMC/BU policy compliance rates for radioisotope and laser safety laboratory inspections
8. Number of radioisotope and laser permit approvals, renewals, and amendments
9. Number of clinical authorized user approvals
10. Number of reviewed and approved policies, manuals, and audit reports.

Appendix II: Radiation Laboratory Rules and Regulations

These rules are designed to limit unnecessary radiation exposures and contamination of the facilities and equipment and to minimize the consequences of a radiation accident if it should occur. Copies of these rules will be posted in the appropriate laboratories.

General Procedures

Eating, drinking, & smoking	Eating, drinking and smoking are not permitted in laboratory areas where radionuclides in liquid form are being used or stored.
Wash hands	Wash hands after handling any radioactive material and before going about any other work. Always wash hands before leaving laboratory.
Pipetting	Never pipette anything by mouth.
Protective Clothing	Always use gloves when handling radioactive material. Lab coats should be worn in the laboratory and left in the laboratory.
Confine the activity	The spread of radioactive contamination may be minimized by working on the tray lined with absorbent material. Radioactive materials that are being transported should be transported in a closed lid secondary container which should resistant to impact and breakage.
Spills	Notify the DMPRS of all spills except those of a very minor nature (note: contamination surveys are required to be performed and documented after a minor spill).
Labeling	Label radioactive material with your name, date, radionuclide, and quantity of radionuclide.
Before leaving	Before leaving the laboratory, clean up and monitor your work area and yourself using appropriate radiation detection instrument. Remove lab coat and wash hands.

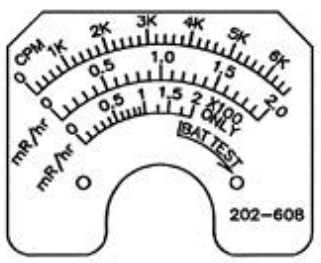
Disposal of Liquid Radiological Waste	Liquid radioactive waste should be stored in plastic bottles if possible. The radionuclide, quantity, and date of disposal must be recorded on the waste container. Small amounts of nontoxic wastes may be disposed of in the sanitary sewer as directed by the RSO.
Disposal of Solid Radiological Waste	Solid radioactive waste must be placed in plastic-lined containers. The radionuclide, quantity, and date of disposal must be recorded on the waste container.
Hoods	Hoods or glove boxes must be used when handling stock solutions of radioactive materials specified by the Radiation Safety Committee as being a potential internal safety (ingested, inhaled or absorbed) hazard.

Appendix III: RADIATION DETECTING AND COUNTING INSTRUMENTATION

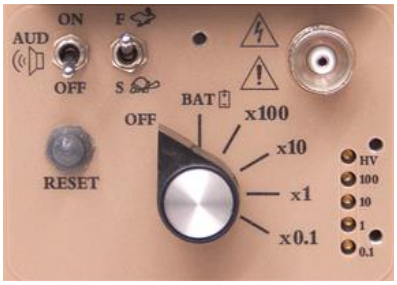
ALL RADIATION DETECTION EQUIPMENT MUST BE CALIBRATED ANNUALY

Ratemeter

The ratemeter or electronic component provides the interface for most contamination monitors. A ratemeter is an instrument that measures the counting rate of incoming electronic pulses. When connected to a radiation-detecting probe, it reports the rate at which radioactive particles are detected. An attached radiation detector provides a signal, which the ratemeter presents as a counting rate. The counting rate is generally given in either counts per minute (cpm) or counts per second (cps).



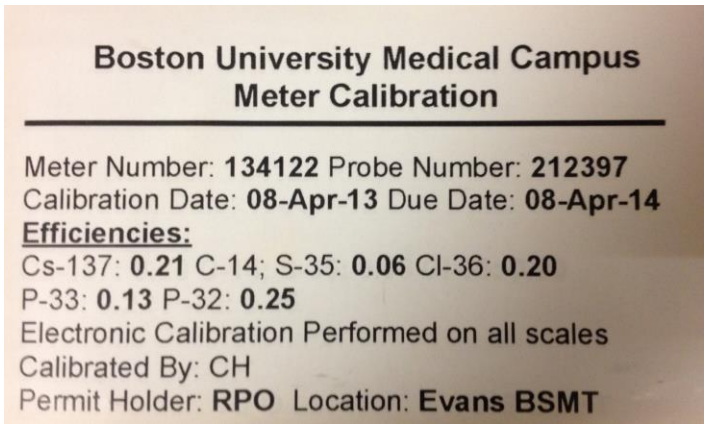
Ratemeter Readout



Ratemeter Controls

The knob on the ratemeter turns the meter on and off, and controls the scale of the readout. To find the correct cpm, multiply the reading on the gauge by the scale selected by the knob. For example, a reading of 2K on the x0.1 scale indicates a counting rate of 200 cpm. Every time you use the ratemeter, you should check the battery level to make sure it's in the acceptable range. If the battery level falls below that range, the detector may still respond, but it won't have enough power to respond reliably, so contamination may go undetected.

Some ratemeters, like the one shown above, display scales for both cpm and mR/hr. These scales are <u>not</u> interchangeable. To measure exposure rate (mR/hr), you would need a probe calibrated specifically for that purpose. Contamination surveys should be reported in cpm.



Boston University Medical Campus
Meter Calibration

Meter Number: **134122** Probe Number: **212397**
Calibration Date: **08-Apr-13** Due Date: **08-Apr-14**
Efficiencies:
Cs-137: **0.21** C-14; S-35: **0.06** Cl-36: **0.20**
P-33: **0.13** P-32: **0.25**
Electronic Calibration Performed on all scales
Calibrated By: CH
Permit Holder: **RPO** Location: **Evans BSMT**

Each ratemeter should have a calibration sticker affixed to either the side or the bottom. This sticker lists the date of calibration as well as efficiencies for commonly used isotopes. The efficiency is the fraction of emitted particles the detector picks up from a particular isotope. Using the above sticker as an example, this particular meter can detect 25% of the particles emitted by P-32, but only 6% of those emitted by C-14 and S-35. The efficiencies listed apply only to that specific probe used with that specific ratemeter. For meters with multiple probes, the numbers refer to the Geiger-Mueller detector unless otherwise specified.

Geiger-Mueller Detector

Also known as a Geiger counter, the Geiger-Mueller (GM) detector is a chamber filled with an inert gas. Ionizing radiation that interacts with either the gas or the wall of the detector will produce an electron and a positive ion. A strong electric field separates the ion pair and causes the electron to liberate other electrons, starting a chain reaction. The amplified charge is collected and registered by the instrument as a single event, producing an audible click.

Pancake Probe

Because of their durability and their ability to detect low levels of radiation, GM detectors are the most common instrument used for detection of radioactive contamination. The two main shapes of GM detectors are the pancake probe and the end-window probe. Pancake probes will have a higher efficiency because they cover more area. Both probes must be connected to a ratemeter to be used. Each probe is calibrated to a specific ratemeter, and should not be swapped out without recalibration. GM probes usually have a thin mica window to allow low-energy particles to enter the chamber. This window is fragile and should be treated with care. If the window is punctured, the entire probe must be replaced. Probes that have red protective caps should have these caps removed prior to conducting radiation monitoring.

End-Window GM

GM detectors are used to detect mid- to high-energy alpha, beta, and gamma particles. They cannot, however, distinguish between different types of particles or different particle energies. Isotopes that emit low-energy gammas (e.g. I-125) or low-energy betas (e.g. H-3) cannot be detected by a Geiger counter, so other instruments must be used.

Sodium Iodide Detector

The sodium iodide (NaI) detector is a type of scintillation detector. It consists of a crystal connected to a photomultiplier tube. When a particle strikes the crystal, a photon is emitted. In the photomultiplier tube, the photon is absorbed and an electron is emitted. This electric signal is heavily amplified by the tube and reported as a count on the ratemeter.

Sodium Iodide Detector

Since the amplitude of the signal produced by a scintillation detector is proportional to the energy of the particle detected, this detector can be used to discriminate between particle energies. A ratemeter, however, is incapable of reporting signal amplitude. The detector must be connected to a different kind of meter in order to be used for this purpose.

The NaI probe is primarily used for gamma detection. The counting efficiency of the detector depends on the thickness of the crystal: thin crystals are better for low-energy gammas (like I-125), and thicker crystals are used for higher-energy gammas. Thin-crystal detectors also feature a thin end window, which should not be punctured or damaged.

Liquid Scintillation Counter

The liquid scintillation counter (LSC) is another type of scintillation detector. In this case, the scintillating medium (called the fluor) is contained in a fluid in which the sample is dissolved or submerged. (Cerenkov counting does not utilize scintillation fluid instead water is used to count high energy betas) Particles emitted from the sample excite molecules in the fluid, which emit photons in the UV range. These photons excite the fluor molecules, which in turn emit photons in the visible spectrum. The visible photons are converted to an electrical signal and amplified in a photomultiplier tube. The number of photons produced is proportional to the particle energy, so the LSC can be used to discriminate between radiation events of different energies.

Liquid Scintillation Counter

The LSC is especially useful for detecting low-energy beta particles, which can be difficult to detect using other methods. Tritium (H-3), for example, can only be detected using an LSC. Alphas can also be counted in the LSC, but energy transmission to the fluor is not as efficient as with betas, so the signal will show up in a much lower energy channel than would be expected. Gammas can be detected in the LSC as well.

There are some drawbacks to using an LSC as opposed to a portable detector. Only removable contamination can be detected, and counting results are not immediately accessible, so careful notes must be taken when conducting a survey. Nevertheless, wipe tests using an LSC are still the best option for laboratories working with low-energy beta emitters.

Energy-Compensated GM

An energy-compensated Geiger Mueller detector consists of a GM tube encased in a metal sleeve. The metal serves as a shield to block a fraction of lower-energy gammas, preventing them from reaching the chamber. This allows exposure rate to be directly correlated with counting rate, enabling the Geiger counter to be used as an exposure meter. Exposure rate can be used as a reasonable estimate of dose rate.

Energy-Compensated GM

The metal sleeve will block alphas and most betas, so many probes incorporate holes in the sleeve that can be uncovered when low-energy gammas or betas are known to be present. The energy-compensated GM is usually inappropriate for a laboratory setting, as a significant amount of activity must be present to give a reliable reading. This detector is common in clinical areas where exposure rate is a concern, although a regular GM or NaI detector should still be used to locate contamination. Some energy-compensated detectors are completely contained inside a ratemeter to prevent damage and increase ease of use.

Ionization Chamber

Like the Geiger counter, the ionization (ion) chamber is a gas-based detector, but it is operated at a much lower voltage. At this voltage, no electron chain reaction takes place. Single events therefore cannot be detected, but the overall accumulation of charge in the air can be measured. Higher-energy particles create more ion pairs, so the signal is proportional to exposure rate, which is proportional to dose rate.

Ion Chamber with Beta Window Exposed

Ion chambers can function using regular air (in open or closed configurations) or a pressurized gas. This flexibility allows them to be constructed in many different shapes and used for many different purposes. Ion chambers are capable of reliably measuring much higher exposure rates than energy-compensated GMs, but they cost significantly more and are more fragile. Ion chambers are primarily used to measure gamma exposure, but some detectors come equipped with thin beta windows that can be uncovered to measure beta exposure.

Instrument application guide

		Can be detected with:		
Nuclide	**Radiation type**	**LSC**	**NaI**	**Geiger Counter**
C-14	Beta	✓		✓
Ca-45	Beta	✓		✓
Cl-36	Beta	✓		✓
Cr-51	Gamma	✓	✓	✓
Cs-137	Beta/Gamma	✓	✓	✓
F-18	Positron	✓	✓	✓
Fe-55	X-ray	✓		
Fe-59	Beta/Gamma	✓	✓	✓
H-3	Beta	✓		
I-123	Gamma	✓	✓	✓
I-125	Gamma	✓	✓	✓
I-131	Gamma	✓	✓	✓
P-32	Beta	✓		✓
P-33	Beta	✓		✓
S-35	Beta	✓		✓
Tc-99m	Gamma	✓	✓	✓

Appendix IV: Guide for Using Portable Survey Meters

What is a Survey Meter?

A survey meter is a portable handheld, electronic instrument used to detect radiation.
It is recommended that a "pancake" type Geiger Mueller (GM) probe be used for isotopes which emit beta radiation and an energy compensated GM probe be used for gamma emitting isotopes with energies greater than 60keV. For low energy photon emitting isotopes (<60keV), it is recommended that a low energy gamma scintillator, such as a NaI detector, be used. ^{125}Iodine is an example of an isotope which emits photons of energy less than 60keV. It should be noted that ^{3}H cannot be detected with a standard lab survey meter and that only very large quantities of ^{14}C can be detected with a Geiger counter.

How to Use a Meter to Monitor Surface Contamination

1. Verify that the meter has been calibrated by the DMPRS within the last year. The meter should have a calibration sticker with the date of calibration and the "cal due" date. If the present date is later than the "cal due" date, DO NOT USE THAT METER.

2. Perform a battery check on the meter. This is usually accomplished by turning the meter's control knob to the "Bat" position and verifying that the meter's output needle swings to the battery OK position.

3. Turn the control knob to place the meter at its most sensitive scale.

4. With the appropriate probe, a meter survey is conducted by slowly passing the probe over the area or object to be surveyed. Be certain that the pass is at a constant velocity (1 probe width per sec is recommended) and sufficient time is allowed for the meter to respond.

5. For surface contamination measurements, the distance from the contaminated object or area should also be constant. A distance of 1cm is suggested. Care should be taken not to contaminate the probe itself!

6. Dose rate measurements should be performed at waist/chest level and/or 1 foot from the ground)

7. Begin any survey by checking yourself first. Each finger should be checked with special attention paid to thumbs. Wrist and forearm areas should be surveyed as well as lab coat sleeves, fronts and pockets. Personal surveys should also include monitoring the bottoms of shoes. Shoe soles are an excellent indicator of the presence or absence of floor contamination.

8. All readings should be recorded. When recording measurements, counts per minute (cpm) or milliroentgens per hour (mR/hr) should be used. The correct unit is determined by the type of probe being used. When a pancake or scintillation probe is used, cpm is the correct unit. When the energy compensated probe is used, mR/hr is the correct unit. Questions related to the correct use of units should be directed to the DMPRS.

9. Please be certain that all readings are recorded as "net". To do this, determine the normal background reading by observing a meter reading in an area where radioactive materials are not used or stored. Subtract this reading from all other measurements taken.

10. When recording background radiation, it is normal to observe fluctuations on the meter scale use an average of the meter fluctuation. General background readings are usually from 30 – 60 cpm with a pancake probe and 200 –500 cpm with a scintillation probe.

How to Use a Meter to Monitor Area Dose Rates

1. Verify that the meter has been calibrated by the DMPRS within the last year. The meter should have a calibration sticker with the date of calibration and the "cal due" date. If the present date is later than the "cal due" date, DO NOT USE THAT METER.

2. Perform a battery check on the meter. This is usually accomplished by turning the meter's control knob to the "Bat" position and verifying that the meter's output needle swings to the battery OK position.

3. Turn the control knob to place the meter at its most sensitive scale.

4. Measure the dose rate at points which are representative of the work area, such as waist/chest level and/or 1 foot from the ground.

5. If the meter reads at the extreme high end of the dose rate scale (i.e. it becomes 'pinned' at the high end), change the control know to the next highest scale. Continue to increase the control knob until the meter registers a dose rate in the low to upper region of the dose rate scale (i.e. the meter is not 'pinned' low or high).

6. All readings should be recorded in terms of dose rate or exposure rate (mrem/hr, mR/hr) and are determined by multiplying the dose rate observed on the meter scale by the appropriate multiplying factor associated with the control knob setting.

Appendix V: Radiation Accident Response

1. GENERAL PROCEDURES

a. Evaluate the accident and call for help. The first person to observe the accident should try to quickly estimate the severity of the situation and evacuate personnel to a safe place such as an assembly or check point. DMPRS must be notified as soon as possible.

b. Confine the hazard. If possible, secure the area and stand in a safe area nearby to provide information and assistance. Reduce the spread of contamination by limiting travel from the area and by checking yourself and the area for contamination.

c. Protect and Evacuate Personnel. Warn other persons in the immediate vicinity and assist any persons who may be contaminated or injured.

2. MINOR SPILLS (Spills which result in dose rates < 5 mR/hr 30 cm from source and contains <10μCi volatile material):

1. NOTIFY: Notify the people in the area that a spill has occurred.
2. IMMEDIATELY REPORT: Report incident to the DMPRS (617-638-7052).
3. PREVENT THE SPREAD: Cover the spill with absorbent material, and prevent access to the area by unauthorized personnel.
4. CLEAN UP: Use disposable gloves and remote handling tongs. Carefully fold the absorbent material. Insert into a plastic bag and dispose of in the radioactive waste container. Also insert into the plastic bag all other contaminated materials such as disposable gloves.
5. SURVEY: With a low range, thin window G-M survey instrument, check the area around the spill, hands, and clothing for contamination. For low-energy beta emitters, conduct wipe tests at the spill area. All survey records must be maintained by the Permit Holder.

3. MAJOR SPILLS (Spills which result in dose rates ≥ 5 mR/hr 30 cm from source OR spills containing >10μCi of volatile material):

1. CLEAR THE AREA: Notify all persons not involved in the spill to vacate the room. Notify the shift supervisor of the spill.
2. IMMEDIATELY CALL FOR HELP: Notify the DMPRS (617-638-7052) or the Control Center immediately: BU/BMC: 617-414-4144 / CRC: 617-353-2105.
3. PREVENT THE SPREAD: If possible, cover the spill with absorbent material, but do not attempt to clean it up. Confine the movement of all personnel potentially contaminated to prevent the spread.

4. SHIELD THE SOURCE: If possible, the spill should be shielded, but only if it can be done without further contamination or without significantly increasing radiation exposure.
5. CLOSE THE ROOM: Leave the room and lock the door(s) to prevent entry.
6. PERSONNEL DECONTAMINATION: Contaminated clothing should be removed and stored for further evaluation by the RSO. If the spill is on the skin, flush thoroughly and then wash with mild soap and lukewarm water. Injured persons should have first aid performed as necessary and decontaminated. If life-threatening injuries are present, the individual should be given immediate life-saving first aid and transported to a hospital for further medical treatment regardless of any contamination present. The hospital should be given prior notification that the patient may be contaminated so that appropriate controls can be implemented.

4. EXPOSURE TO SOURCES OF RADIATION

Terminate the source of exposure and prevent others from being exposed. Use additional shielding as needed. Notify the DMPRS so the nature and extent of exposure can be determined and, if a severe exposure is suspected, seek medical attention.

5. LOSS, THEFT, OR DAMAGE TO A SOURCE OF RADIOACTIVE MATERIAL

If a radioactive source is lost, stolen, or damaged, notify the RSO immediately!

6. GENERAL POWER FAILURE OR FUME HOOD BLOWER FAILURE

In the event that you are working with volatile radioactive material that requires a fume hood the following procedures should be followed:

a. CLEAR THE AREA: Notify all persons to vacate the restricted area. Notify the RSO or designee if necessary.

b. HAVE A SURVEY PERFORMED BY THE RSO OR DESIGNEE: After the power is restored, use an appropriate survey instrument to check the area in vicinity of the fume hood or radioactive material storage area. Take swipe tests of the area of concern. Check the airflow into the hood.

c. RETURN TO THE AREA: If no abnormal reading were found, proceed with CLEAN UP and SURVEY steps as stated above in MINOR SPILLS.

APPENDIX VI: PERMIT HOLDER RESPONSIBILITIES

BOSTON UNIVERSITY

Division of Medical Physics and
Radiation Safety
80 East Concord Street
Boston, Massachusetts
02118
Tel: 617.638.7052
Fax: 617.638.7509

PERMIT HOLDER RESPONSIBILITIES

Permit Holders are approved by the Radiation Safety Committee to possess and use radioactive materials on the BU/BMC campuses. As a Permit Holder, your responsibilities include:

1. You are responsible for the practices and procedures implemented by all users of radioactive material listed on your permit.
2. You, as the Permit Holder, must attend the basic indoctrination radiation safety course and subsequent biennial refresher training.
3. You must ensure that all new employees to be listed on your permit attend the Radiation Protection Basic Indoctrination Class before they are allowed to use radioactive materials.
4. You must ensure that all users listed on your license attend the biannual (once every two years) radiation safety refresher training.
5. You MUST NOT allow untrained or unauthorized persons to use radioactive material in your possession. This includes individuals that have not attended the biannual refresher training when required.
6. You must ensure that your permit is posted in an area generally accessed by users.
7. You must ensure that the name of the laboratory supervisor and all authorized users listed on your permit are accurate at all times.
8. You must communicate changes in your permit (e.g., new persons, adding locations, removing locations, etc.) to the Radiation Protection Office as soon as possible.
9. You must ensure that laboratory surveys and wipe tests are performed at the frequency specified by the Radiation Protection Office.
10. You must correct all deficiencies in your laboratory identified during Radiation Protection Office inspections within two weeks of notification. If a corrective action cannot be completed within a two-week timeframe the reason must be communicated to the Radiation Safety Officer with an estimated time to completion.
11. You must submit a renewal application for your permit every two years. (You will be notified by the RPO approximately one month before your renewal date.)

APPENDIX VII: RESEARCH AUTHORIZED USER RESPONSIBILITES

Radiation Protection Office
80 East Concord Street
Boston, Massachusetts
02118
Tel: 617.638.7052
Fax: 617.638.7509

RESEARCH AUTHORIZED USER RESPONSIBILITIES

Your responsibilities as an Authorized User of radioactive materials are listed below.

1. You must attend the Radiation Safety Basic Training Class before using radioisotopes.
2. You should know where your permit is posted.
3. You must use only the radioisotopes listed on your permit.
4. You must use radioisotopes only in the locations listed on your permit.
5. You should only dispose of liquid radioactive wastes down the sink designated for that purpose, and you must complete the sink disposal log sheet.
6. You must know how to perform surveys for radioactive contamination.
7. You must wear a laboratory coat, safety glasses and latex gloves when working with radioactive materials.
8. You must know how to respond and who to contact in an emergency.
9. You must remove all radioactive symbols from labels before disposing.
10. You must participate in the whole body and ring radiation dosimetry program if you work with greater than 1 millicurie of gamma (Cr-51) or positron emitter or with 1 millicurie of greater than 500 keV maximum energy beta emitter (P-32) at one time.
11. You must read and understand the protocol specific safety requirements and the laboratory SOP.
12. You must follow all laboratory safety procedures at all times.
13. You must report any accident, potential exposure, or safety concerns to your supervisor immediately.

Print Name: _____
Signature:_____
Date:_____

Appendix VIII: Guide for Performing Radiation Surveys

Introduction

Routine laboratory surveys are an important part of the radiation safety program and are required to be performed by radiation laboratory personnel following the use or transfer of radioactive material. Surveys provide a direct measure of area radiation levels and detect the presence of radioactive material inadvertently spilled on a person, surface, or piece of equipment. Surveys are therefore an indication of the radiation hazard present either during or after an experiment. It is vital that individuals working with radioactive materials are aware of accepted procedures for performing such surveys. The information which follows is a suggested guide for performing surveys of laboratory areas. Questions about the mechanics of performing surveys or the interpretation of this guide may be referred to the DMPRS.

What Is a Survey?

A survey is an evaluation of work areas, instruments and apparatus, floors, sinks, faucet handles, drawer fronts, doorknobs, telephones, light switches, refrigerators, etc. for the presence of radioactive contamination.

Survey results should be documented but certain actions within the laboratory require that surveys be performed and documented. Required actions prompting a radiation survey are presented below. All survey records should be kept so that all information is readily obtainable by laboratory staff or members of the DMPRS.

How Often Are Surveys to be Performed?

Individuals are required to survey themselves and their work areas on an "as used" or "daily basis". The DMPRS recommends frequent surveys of hands and other skin areas to identify and rectify contamination, thus preventing significant doses and internal exposures. An operating survey meter should be accessible whenever working with radiation.

The Permit Holder of a radiation laboratory *is required* to have a radiation survey conducted under the following conditions:

1. After each day of radioactive material usage/experimentation.
2. After transfer of radioactive material from stock solutions.
3. After <u>each</u> experimental run if there is a possibility of a change in radiation levels or contamination.
4. After a minor radioactive spill clean-up or emergency.

<u>NOTE:</u> All Radioactive spills or emergencies, unless minor, are to be reported to the DMPRS ASAP!

What Type of Survey Do I Need to Perform?

The type of survey that you perform depends on what type of radioactive material is used…

Radioactive Sealed Source

Sealed sources are radioactive sources which have been encapsulated to prevent potential contamination. The DMPRS checks such sources for radioactive material leakage on a semiannual (6 month) basis.

Contamination Surveys

Contamination surveys (also called swipes or wipe surveys) are performed to detect the presence of removable contamination and are necessary when using radioactive liquids, solids, or gases. As described in the above section titled *"How Often are Surveys to be Performed",* wipe surveys are required to be performed:

1. After each day of radioactive material usage/experimentation.
2. After transfer of radioactive material from stock solutions.
3. After each experimental run if there is a possibility of a change in radiation levels or contamination.
4. After a minor radioactive spill or emergency.

What Is Contamination?

The laboratory must be aware of the two types of radioactive material contamination:

Fixed contamination is that which has become bound by chemical or other means to the surface upon which it was deposited. This form of contamination can only be detected by a survey meter through a radiation area survey. Because it is fixed to the surface, a wipe test will indicate little or no activity. A meter survey may indicate that larger quantities are indeed present on the surface.

Removable contamination is that which may be wiped off a surface or object, similar to dust on a piece of furniture. The presence of removable contamination is determined by wipe tests and in some situations by the use of a survey meter. If contamination is present in large enough quantities and is removable, it also may be detected by a survey meter when a wipe test of the surface is placed near the probe.

How to Perform a Contamination Survey for detection of Removable Contamination

1. Obtain a blank survey form (or your laboratory's survey log book) and decide which areas you wish to test for contamination.
2. Record your name and the date and document the areas you plan to analyze on your survey form.

3. Find out what material the laboratory uses to perform its wipe test. A Whatman 41 filter or its equivalent is best used for contamination testing purposes.

4. Take the wipe paper, and wipe an area equivalent to roughly 100 cm^2 in an area of interest.

5. Determine the Removable Contamination Limits for which the laboratory must meet. A 100 cm^2 area must have removable contamination greater than or equal to the following limits to be considered contaminated:
    a. Beta/gamma radiation (except tritium) - 500 dpm/100cm^2.
    b. Tritium - 1,000 dpm/100cm^2.

6. Determine the radiation wipe analysis method suitable for the isotope(s) used:
    a. High energy beta/gamma source – Open window Geiger Counter (if approved by DMPRS).
    b. Low energy beta, high energy beta – Liquid scintillation counter, gas flow proportional counter.

7. Analyze the sample as appropriate for the analysis method used.

8. If the removable contamination limits exceed those detailed above in step 5, contact the Permit Holder. In any case, alert the DMPRS before attempting to handle the contamination. Options for handling contaminated areas include:
    a. Clean up the contamination until measurable radiation levels fall below the contamination limits.
    b. Posting the area as a contaminated area.

9. Once the contaminated area has been cleaned, perform one last recorded radiation contamination survey to ensure area falls below the contamination limits described above.

Appendix IX: BOSTON UNIVERSITY / BOSTON MEDICAL CENTER CONTAMINATION ACTION LIMITS FOR RELEASE

	Restricted Use		**Unrestricted Use**		**Action if > Release Limit**	
Half-Life	*Alpha*	*Beta/Gamma*	*Alpha*	*Beta/Gamma*	*Room*	*Equipment*
< 24 hours	200	20,000	20	2,000	Hold for decay*	Hold for decay
> 24 hours	100	2,000	20	1,000	Clean	Hold for decay**
I-131	-	2,000	-	200	Clean	Hold for decay

* CAUTION – The decision to prevent access to a room or area while waiting for alpha emitting isotopes to decay must be undertaken very carefully. Rooms or areas to which access is denied for greater than 8 working hours due to radioactive contamination will trigger an immediate report to the state Radiation Control Program. Alternate control strategies that will not trigger reporting requirements should be considered such as allowing access only by approved authorized users and implementing survey in and out protocols.

** Equipment such as refrigerators, centrifuges, etc., may be held for decay provided the half-life of the contaminating isotope does not require holding the item for extended periods. Depending on storage capability, equipment and items should not be held for more than 6 months for practicality purposes unless approved by the Executive Director of EHS.

Most Commonly Used Radioisotopes at BU/BMC

Radioisotope	Half-Life in hours	Energy
F-18	1.8	633.2 keV (Positron) 0.511 MeV x2 (gamma)
Tc-99m	6.0	140.5 keV (gamma)
I-123	13.2	158.9 keV (gamma)
Tl-201	72	167 keV (gamma)
Xe-133	124.8	81 keV (gamma)
P-32	343.2 (14.3 days)	1710 keV (Beta Max)
P-33	607.2 (25.3 days)	249 keV (Beta Max)
Cr-51	664.8 (27.7 days)	320 keV (gamma)
I-125	1430.4 (59.6 days)	27 keV (xray) 35 keV (gamma)
S-35	2097.6 (87.4 days)	166.7 keV (Beta Max)
Fe-55	23827.2 (2.72 years)	<10 keV (X-ray; Auger)
H-3	108186 (12.35 years)	18.6 keV (Beta Max)
Sr-90	249660 (28.5 years)	546.2 keV (Beta Max)
C-14	50194800 (5730 years)	156.5 keV (Beta Max)

*Half-life and Energy from NCRP Report No. 58

Appendix X: DPH Notice to Employees

MASSACHUSETTS DEPARTMENT OF PUBLIC HEALTH
RADIATION CONTROL PROGRAM

NOTICE TO EMPLOYEES
STANDARDS FOR PROTECTION AGAINST RADIATION;
NOTICES, INSTRUCTIONS AND REPORTS TO WORKERS; INSPECTIONS

The Radiation Control Program (Agency) of Massachusetts Department of Public Health has adopted regulations in 105 CMR 120.200 which establish standards for your protection against radiation hazards. In 105 CMR 120.750, the Agency has also established certain provisions for the options of workers engaged in work under the Department license or registration.

YOUR EMPLOYER'S RESPONSIBILITY

Your employer is required to—

1. Apply these regulations to work involving sources of radiation.
2. Post or otherwise make available to you a copy of the Massachusetts Department of Public Health regulations for control of radiation, and the operating procedures which apply to work you are engaged in, and explain their provisions to you.
3. Post Notice of Violation involving radiological working conditions, proposed imposition of civil penalties and orders.

YOUR RESPONSIBILITY AS A WORKER

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

WHAT IS COVERED BY THESE REGULATIONS

1. Limits on occupational exposure to radiation and radioactive material;
2. measures to be taken after accidental exposure;
3. personnel monitoring, surveys, and equipment;
4. caution signs, labels, and safety interlock equipment;
5. exposure records and reports;
6. options for workers regarding Agency inspections; and
7. related matters.

REPORTS ON YOUR RADIATION EXPOSURE HISTORY

1. The Department of Public Health regulations require that your employer give you a written report if you receive an exposure in excess of any applicable limit as set forth in the regulations or in the license. The basic limits for exposure to employees are set forth in 105 CMR 120.211 through 120.218 of the regulations. These sections specify limits on exposure to radiation and exposure to concentrations of radioactive material in air.
2. If you work where personnel monitoring is required:
   (a) your employer must advise you of your occupational radiation dose each year, and
   (b) upon termination of employment, your employer must give you a written report of your dose if you request it .

INSPECTIONS

All licensed or registered activities are subject to inspection by representatives of the Department of Public Health, Radiation Control Program. In addition, any worker or representative of workers who believes that there is a violation of the M.G.L.c.111, the regulations issued thereunder, or the terms of the employer's license or registration with regard to radiological working conditions in which the worker is engaged, may request an inspection by sending a notice of the alleged violation to the Department of Public Health, Radiation Control Program. The request must set forth the specific grounds for the notice, and must be signed by the worker as the representative of the workers. During inspections, Department inspectors may confer privately with workers, and any worker may bring to the attention of the inspectors any past or present condition which he believes contributed to or caused any violation as described above

INQUIRIES

Direct all inquiries on the matters outlined herein to:

Massachusetts Department of Public Health
Radiation Control Program
Schrafft Center, Suite 1M2A
529 Main Street
Charlestown, MA 02129
Telephone: (617) 242-3035
Fax: (617) 242-3457
Emergency Phone: (617) 242-3453

POSTING REQUIREMENT

COPIES OF THIS NOTICE MUST BE POSTED IN A SUFFICIENT NUMBER OF PLACES IN EVERY ESTABLISHMENT WHERE EMPLOYEES ARE EMPLOYED IN ACTIVITIES LICENSED OR REGISTERED, PURSUANT TO 105 CMR 120.750, BY THE DEPARTMENT OF PUBLIC HEALTH, RADIATION CONTROL PROGRAM, TO PERMIT EMPLOYEES WORKING IN OR FREQUENTING ANY PORTION OF A RESTRICTED AREA TO OBSERVE A COPY ON THE WAY TO OR FROM THEIR PLACE OF EMPLOYMENT.

Appendix XI: BU Radioisotope Posting

Boston University and Boston Medical Center

REGULATIONS GOVERNING THE USE OF RADIOISOTOPES

AUTHORIZATION

Only those individuals authorized by the Department of Medical Physics and Radiation Safety (DMPRS) may order, use, bring into, or remove radioisotopes from Boston University and/or Boston Medical Center. Every individual working with radioisotopes or in radiation-controlled areas must be registered with the DMPRS.

TRAINING

Only those individuals who have been appropriately trained to ensure safe working habits and prevention of exposure to others or contamination of the surroundings may work with radioisotopes.

RESPONSIBILITIES

Work with radioisotopes must be done in accordance with the BU/BMC Radioisotope Use Manual.

These regulations cover maximum exposure limits, posting of areas, monitoring procedures, procurement, delivery, storage, waste disposal, records, transportation, protective clothing, contamination, work habits, procedures, accidents, and termination of work.

NOTIFICATION

The DMPRS (617-638-7052) must be promptly notified of all incidents. This includes overexposure to radiation, spread of contamination, difficulty cleaning up a contaminated area, and any violations or unsafe practices.

The DMPRS must be notified in the event of loss or misplacement of radioisotopes and sources. The Radiation Safety Officer shall be promptly notified of any unsafe practices with radioactive materials.

RULES FOR EFFECTIVE RADIATION SAFETY

1. Ensure that only individuals authorized by the DMPRS have access to radioactive materials.
2. Keep external radiation exposure to a minimum by planning your work with minimum exposure in mind. Frequently monitor yourself and your work area
3. Ensure work practices prevent or minimize the potential for ingestion, inhalation, and dermal absorption of radioactive materials.
4. Wear appropriate personal protective equipment such as gloves, lab coat, and close-toed shoes when in the laboratory.
5. Observe laboratory safety rules at all times.
6. In the event of a significant spill or accidental release:
   - ✓ Restrict access to contaminated area(s).
   - ✓ Prevent spread of contamination with absorbent material.
   - ✓ Notify the DMPRS.
7. In the event of personnel contamination (suspected or known):
   - ✓ Remove and isolate any contaminated clothing.
   - ✓ Wash contaminated skin with soap and water for at least 3 minutes.
   - ✓ Notify the DMPRS.

BOSTON UNIVERSITY/BOSTON MEDICAL CENTER
Division of Medical Physics and Radiation Safety
EXT. 617-638-7052

CALL THE DMPRS WHENEVER QUESTIONS ARISE CONCERNING A RADIATION HAZARD OR PROPER PRACTICES IN WORKING WITH RADIOACTIVE MATERIAL. EMERGENCY EXTENSIONS DURING THE DAY – 617-638-7052
OFF-HOURS CONTROL CENTER: BU MEDICAL CAMPUS AND BMC 617-638-6666 / CRC 617-353-2105

Appendix XII: Forms

General

Laboratories licensed for sink disposal must use the Sink Disposal Reference Guide to decide if the radioactive material may be disposed of into the sewer. In addition, basic forms are included for the Authorized User to use when performing the following functions within the laboratory:

1) Form DMPRS 1: "Radioactive Material Use Log "
2) Form DMPRS 2: "Declaration of Pregnancy"
3) Form DMPRS 3 – "Request for Radiation Monitoring"
4) Form DMPRS 4-"BU/BMC Sink Disposal Limits of Radioisotopes (*note: this form must be posted next to a sink approved by the Radiation Safety for radioactive materials disposal*)
5) Form DMPRS 5: Radiation Waste Disposal Log
6) Form DMPRS 6: Sample Survey Map

DMPRS 1: Radioactive Material Use Log

Radiation
Protection Office
Evans Basement
80 East Concord Street
Boston, Massachusetts
02119-2511
Tel: 617.638.7052
Fax: 617.638.7509

Radioisotope Use Log

Isotope:	
Compound:	
Date Received:	
Activity Received:	
Lot #:	
Storage Location:	

Date Used:	Activity Used:	Activity Remaining:	User Name:

DMPRS 2: Voluntary Declaration of Pregnancy

DECLARATION OF PREGNANCY

In accordance with Massachusetts regulation 105 CMR 120.218, a pregnant woman who wishes to limit radiation dose exposure to the fetus/embryo resulting from her occupational exposure, must voluntarily, and in writing, declare her pregnancy to her employer, so that the employer may apply the required fetal dose limits for the duration of the pregnancy.

Pursuant to Massachusetts regulation 105 CMR 120.218(A), "*Dose Equivalent to an Embryo/Fetus*", the dose exposure to an embryo/fetus during the entire pregnancy, due to occupational exposure of a declared pregnant woman, is not to exceed 500 millirem (5 milliSieverts). 105 CMR 120.218(B) and 120.267(D) require efforts to avoid substantial variation above a uniform monthly exposure rate to a declared pregnant woman to satisfy the limit in 105 CMR 120.218(A), and require that the estimated date of conception be provided to allow the employer to calculate the cumulative fetal dose. A monthly dose limit of 50 millirem (.5 milliSieverts) will be applied to you during the duration of your pregnancy. A fetal dosimeter will be issued to you each month during this period to monitor exposure to your unborn child.

Accordingly, I am voluntarily declaring that I am pregnant. I believe that I became pregnant in _____(Month/ Year). This declaration inherently expires one year from the approximate conception date.

Signature: _____ Date:

(PLEASE PRINT)

Name: _____ Identification Number:

Email Address: _____ Phone:

Department: _____ Supervisor:

Are you occupationally exposed to sources of radiation at a place of work other than Boston University/ Boston Medical Center? _____ Yes _____ No

If yes, please provide the name and address of any other places of work: _____

DMPRS 3- "Request for Radiation Monitoring"

Request for Monitoring must be completed online:

http://www.bu.edu/ehs/plans/management-plans/rpo/request-for-personnel-monitoring/

DMPRS 4: BU/BMC Sink Disposal Limits of Radioisotopes

Radiation
Protection Office
Evans Basement
80 East Concord Street
Boston, Massachusetts
02119-2511
Tel: 617.638.7052
Fax: 617.638.7509

SINK DISPOSAL LIMITS

Isotope	uCi/day	uCi/month @ 1 time
Calcium-45	10	0
Carbon-14	100	0
Cerium-141	10	0
Chlorine-36	10	0
Chromium-51	100	3,000
Cobalt-57	10	0
Cobalt-60	10	0
Cooper-64	100	0
Gallium-57	10	0
Hydrogen-3 (Tritium)	500	5,000
Indium-111	10	0
Indium-113	100	0
Iodine-125	50	1,000
Iodine-131	10	0
Iron-155	100	0
Iron-59	10	0
Manganese-54	10	0
Niobium-95	10	0
Phosphorus-32	250	0
Phosphorus-33	100	0
Platinum-195	100	0
Potassium-42	10	0
Rubidium-86	10	0
Rutheniom-103	10	0
Ruthenium-106	100	0
Scandium-46	100	0
Selenium-75	10	0
Sodium-22	10	0

Isotope	uCi/day	uCi/month @ 1 time
Sodium-24	10	0
Strontium-85	10	0
Strontium-89	10	0
Sulphur-35	250	3,000
Technitium-99	100	0
Thallium-201	100	0
Thallium-204	100	0
Tin-113	10	0
Xenon-133	100	0
Ytterbium-169	10	0
Zinc-62	10	0
Zinc-65	10	0

Note 1: *Consult the Radiation Protection Office for limits of any isotope(s) not listed.*

Note 2: *Greater limits of any radioisotope may be approved by the Radiation Protection Officer on one time basis only or by the Radioisotope Committee for continual disposal.*

Radiation Protection Office
80 East Concord Street
Boston, Massachusetts
02118
Tel: 617.638.7052
Fax: 617.638.7509

Radioactive Waste Barrel Disposal Record

Permit Holder: _____ **Code:** _____ **Barrel Location:** _____

DEFACE ALL LABELS, SYMBOLS, TAPE, and/or CONTAINERS
NO LIQUIDS, NO NEEDLES

DATE	ISOTOPE	ACTIVITY	INITIALS

RADIOLOGICAL SURVEY RECORD

Location: **Purpose:** **Permit Holder:**

Survey Results (dpm/100cm^2)			
1		21	
2		22	
3		23	
4		24	
5		25	
6		26	
7		27	
8		28	
9		29	
10		30	
11		31	
12		32	
13		33	
14		34	
15		35	
16		36	
17		37	
18		38	
19		39	
20		40	

Action Limits	
< 500	nothing
< 2,000	decon
>2,000	decon + rpt

Remarks

Sink:_____Survey:_____Rad. waste:_____Posting:_____Inventory:_____Meter:_____Labcoat:_____

Signatures		Instrument Information				Legend
Surveyed by:	**Date:**	**Type**	**Ser/No**	**Cal. Date**	**Bkgd cpm**	○ swipe
		GMPP				□ fixed
Reviewed by:	**Date:**	NaI				◇ dose rate
		LSC				

RPO-C/R-005.0

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