University of Massachusetts Lowell
Lowell, Massachusetts

Radiation Safety Guide

March 2007 Revision

In the event of a Radiation Emergency:
Call the *Radiation Safety Office:*
(978) 934-3372
(978) 934-3373
If unavailable or after regular working hours:
Call *University Police*:
(978) 934-2911

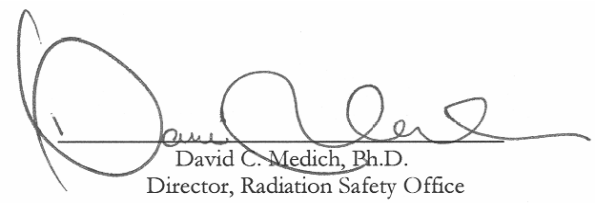
UNIVERSITY OF MASSACHUSETTS LOWELL

Radiation Safety Guide

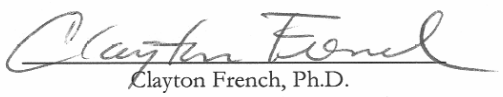
Revised March 2007

Radiation Safety Office
University Of Massachusetts Lowell
Pinanski Building, Room 111
1 University Avenue
Lowell, MA 01854
(978) 934-3372

APPROVALS:



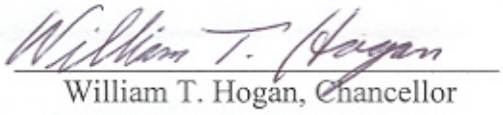
David C. Medich, Ph.D.
Director, Radiation Safety Office



Clayton French, Ph.D.
Chairman, Radiation Safety Committee

PREFACE

This Radiation Safety Guide contains the policies, regulations, and recommended procedures for the safe use of radiation sources at the University of Massachusetts Lowell. It is incorporated as a condition in each radioactive material license issued to the university by the U.S. Nuclear Regulatory Commission and the Massachusetts Department of Public Health and must be adhered to by all radiation users. Although overall responsibility for radiation safety rests with the university, basic responsibility for the protection of life and property must be assumed by the individual user of the radiation source. Thus, an individual desiring to use radioactive materials or radiation emitting devices must possess acceptable qualifications and follow designated policies and procedures as outlined in this guide.



William T. Hogan, Chancellor

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Section 1

Introduction

The use of radioactive materials and radiation generating equipment is strictly regulated by federal and state agencies to ensure the safety of the radiation worker and the public. It is important for all individuals within this university who use radioactive materials or radiation emitting devices to read and abide by the rules documented within this guide.

Radioactive materials and radiation emitting devices 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, and university radiation safety regulations and standard practices.

Radiation sources at the University of Massachusetts Lowell (UML) are regulated by the U.S. Nuclear Regulatory Commission (NRC) and the Commonwealth of Massachusetts Department of Public Health (DPH). Through these agencies, the University has been granted three broad scope licenses to manage its campus radiation safety program. These licenses offer the University the necessary degree of flexibility and autonomy necessary for a research institution to purchase, use, store, and dispose of radioactive materials. As part of the requirements of our broad scope licenses, the University is required to appoint a Radiation Safety Committee (RSC) and a Radiation Safety Officer (RSO) to develop and manage the university radiation safety program. This program is subject to periodic audits by the NRC and DPH to verify our regulatory compliance and to ensure the safety of university personnel and members of the public.

This Radiation Safety Guide describes the organization of the Radiation Safety Committee, the Radiation Safety Office and the services available to all users of radioactive sources and radiation emitting devices. This Guide is consistent with the applicable Federal and State regulations and is in accordance with the requirements of our university licenses. Since compliance with the above licenses does not in itself ensure a safe program, additional rules and procedures have been specified in this Guide to enhance our Radiation Safety Program.

Section 2

ALARA Policy

The University of Massachusetts Lowell is 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 to radiation.

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 UML consists of the following elements:

A. Training: A radiation safety training program is provided by the radiation safety office. 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 university. The Radiation Safety Office will investigate any radiation exposures greater than 10% of the regulatory limits listed in Table 1, Section 4 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 UML Radiation Safety Committee reviews and must approve of all experiments in which radioactive material is used. In addition, the RSO and RSC annually audit the radiation safety program of each Authorized User or radioactive sources to verify compliance with federal, state, and university regulations. The RSO may require Authorized Users to show how well their project meets the ALARA principles.

Section 3

ORGANIZATION, AUTHORITY, AND RESPONSIBILITY

The organization, authority, and responsibility for the UMass Lowell radiation safety program is presented in Figure 1. The main components of the UMass Lowell Radiation Safety Program are:

A. Radiation Safety Office,

B. Radiation Safety Committee and Subcommittees,

C. Authorized Users of radioactive materials and radiation emitting devices,

D. Radiation Worker.

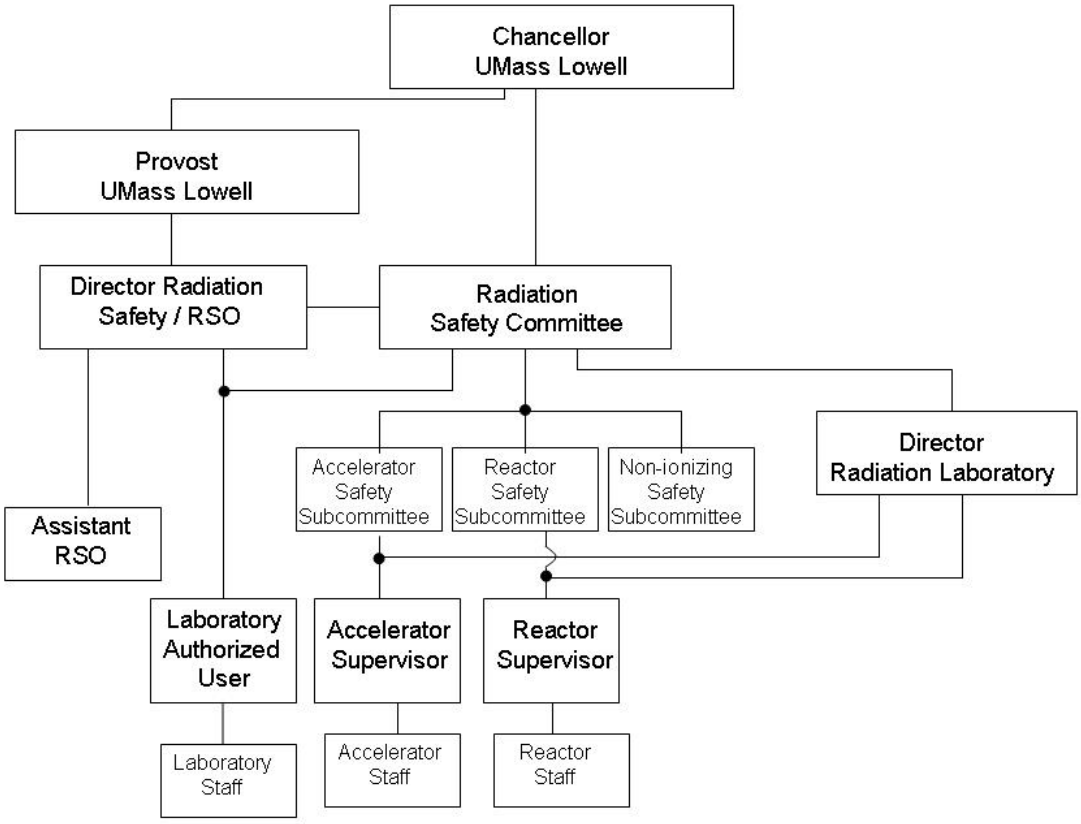

Figure 1: Organizational Chart of the UMass Lowell Radiation Safety Program

Radiation Safety Office

General:

The Radiation Safety Office, managed by the Director of Radiation Safety, is responsible for assuring compliance with relevant Federal, State, and University regulations and enforces policies established by the Radiation Safety Committee. The Radiation Safety Office maintains a staff adequate 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 Radiation Safety staff is granted the right to immediately stop all radiation related work in a laboratory determined to be out of compliance with accepted radiation safety standards and practices.*

Such stoppages may proceed for no more than forty eight hours without the expressed approval of either the Director of Radiation Safety or the Chairman of the Radiation Safety Committee or, in their absence, their designee. Members of the Radiation Safety Office have the right to petition the Radiation Safety Committee to ban workers or laboratories from using radioactive materials or radiation producing devices if these individuals or laboratories have been identified as exhibiting a history of non-compliance with university, state, or federal rules and regulations. The Director of 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.

Director of Radiation Safety:

The Radiation Safety Office is managed by the Director of Radiation Safety (DRS). The DRS oversees the daily affairs of the campus radiation safety program and serves as the Radiation Safety Officer (RSO) on each university radioactive materials broad scope license. As the Radiation Safety Officer, the DRS is responsible for developing and managing the 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 in the University and is distributed in the form of a Radiation Safety Guide for the university.

Applications for the generation, purchase, use, or disposal of radioactive sources or devices shall be reviewed by the DRS and may approve the purchase of radioactive materials for previously reviewed experimental protocols. With agreement from the Accelerator or Reactor Supervisor (as appropriate), or their designees, the DRS may

also approve applications for routine accelerator or reactor use provided that such use has been previously reviewed by the appropriate Safety Subcommittee.

Researchers wishing to perform a new, and therefore un-reviewed, experiment using radiation emitting materials or devices must submit an application to the DRS for a radiological safety review. The DRS shall review the protocol for content and, when complete, submit it to Radiation Safety Committee for approval. The Committee may either directly review the application or, when necessary, appoint an Ad Hoc Subcommittee to review the safety issue. The Ad Hoc Subcommittee decision is binding subject to approval by the Committee. As a requirement of the UMass Lowell radiation safety program, the Director of Radiation Safety shall serve as a permanent member of the Radiation Safety Committee and all its subcommittees.

In his absence, the DRS may designate an individual to act on his behalf for all management, safety, and approval issues related to the campus radiation safety program.

Radiation Safety Office List of Services:

The Radiation Safety Office provides the following services:

1. personnel monitoring,
2. radiation and radioactivity monitoring,
3. radiation instrument calibration,
4. waste pick-up and disposal,
5. consultant services,
6. transportation and shipping assistance,
7. emergency assistance, and
8. radiation safety training.

These services are explained in Appendix II.

Radiation Safety Committee and Subcommittees

Membership:

The members of the Radiation Safety Committee are appointed by the Chancellor of the University of Massachusetts Lowell (UMass Lowell) and are selected to represent broad areas or divisions within the university of individuals who use or encounter radiation sources.

Committee Responsibilities, Delegation of Authority, and Subcommittees:

The Radiation Safety Committee is responsible for assuring that an adequate safety program is developed and implemented within the university and publicizes campus radiation safety policy, regulations, and procedures. The Radiation Safety Committee 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 Radiation Safety shall be a permanent member of the Radiation Safety Committee and of all of its subcommittees."[1]

The Radiation Safety Committee is responsible to hold quarterly meetings to discuss radiation related safety issues and to review issues discussed in the Safety Subcommittees. The RSC shall also provide an annual review or audit of the UML radiation safety program.

The Accelerator/X-ray Safety Subcommittee reviews all aspects of radiation safety in and around accelerator and x-ray facilities. Subcommittee members are appointed by the Radiation Safety Committee and include the Radiation Laboratory Director, The Director of Radiation Safety, and those persons with training and experience relative to accelerator operations and accelerator safety.

The Reactor Safety Subcommittee reviews the safety aspects of the research reactor. Subcommittee members are appointed by the Radiation Safety Committee and include the Reactor Supervisor, Director of Radiation Safety, persons with training and experience in reactor safety and operations, and persons with specific expertise in various reactor related scientific and engineering experimental disciplines. Decisions of the Subcommittee are binding subject to the ultimate approval by the Committee.

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[1] Authorized Personnel: In reference to all procedures for the operation of the accelerator, authorized persons are those persons who have satisfactorily completed a training program with the Accelerator Engineer and who have been approved by the Accelerator Safety Subcommittee.

* A current list of Committee/Subcommittee members are in Appendix I.

Committee Meetings:

The Radiation Safety Committee and Reactor Safety Subcommittee are required to hold quarterly meetings. All committees must hold a meeting within thirty days of a committee member presenting a formal request to the DRS. Binding committee decisions require a majority of the members to be present including the Director of Radiation Safety or his/her designee. Minutes of the meeting will be recorded and kept on file for review.

Authorized Users

The Authorized User (AU) is responsible for safe and proper use, storage, and disposition of radioactive material or radiation emitting devices within an approved radiation laboratory. An approved radiation laboratory is a laboratory which has been reviewed by and approved for radioactive material or device use by the Radiation Safety Committee.

> *No laboratory or individual shall procure, use, store, or dispose of quantities of radioactive material covered under our broad scope licenses unless an approved Authorized User is available and the laboratory has been approved for operations as a radiation laboratory by the Radiation Safety Committee*.

The Authorized User shall verify that all persons within his/her laboratory are properly trained and aware of the radiation hazards and responsibilities associated with operating a radiation laboratory. The AU assumes responsibility for assuring that his/her radiation laboratory is fully compliant with all federal, state, and university regulations and that the laboratory follows the procedures documented in this guide.

Requirements for Authorization

1. The individual desiring to become an AU must be on staff or formally associated with either the University of Massachusetts Lowell or the UML Research Foundation. In certain cases where technically qualified individuals from outside UML request use of a particular source/facility to carry out a relatively long-term or repetitive experiment such individuals may be given temporary use authorizations. Under such authorizations the individuals are governed by the same requirements as any other UML Authorized User.

2. The individual must have adequate experience and training for the requested authorization

3. The individual must be familiar with the requirements of this guide and have made adequate provisions for radiation safety and control

4. Facilities and equipment for safe conduct of activities must be available. A radiation laboratory must also meet the safety requirements of the EH&S Department.

5. The individual must receive written authorization from the Radiation Safety Committee or the Director of Radiation Safety

6. The use of radioactive materials by undergraduate students for educational purposes will be under the direct supervision of an Authorized User.

Becoming an Authorized User:

Individuals desiring to become an Authorized User must submit the application form HP-2: 'Application form to become an Authorized User of Radioactive Materials" along with a C.V. or resume to the Director of Radiation Safety. Form HP-2 may be obtained from the Radiation Safety Office and is included in Appendix IX of this manual. Once the application is determined to be complete by the DRS, it will be submitted to and reviewed by the Radiation Safety Committee.

Individuals are designated as an Authorized User by the Radiation Safety Committee after careful consideration of their training and experience with radiation sources or devices. Adequate training and experience for an applicant is demonstrated through the following:

1. The applicant should have, at a minimum, a college degree at the bachelor level or equivalent training and experience in physical, chemical, biological sciences, or engineering. Extensive radiation-related work experience (>7 yrs) may be used as a substitution.

2. The applicant shall have training and experience commensurate with the scope of the proposed activities. Training should include the following subjects:

    a. Radiation protection principles,
    b. Characteristics of ionizing radiation,
    c. Units of radiation dose and quantities,
    d. Radiation detection instrumentation,
    e. Biological hazards of exposure to radiation,
    f. Hands-on use of radioactive materials.

If the applicant wishes to be an Authorized User of a laboratory that has not been previously approved by the Radiation Safety Committee or if the applicant wishes to use or store new / additional isotopes at a previously approved Radiation Laboratory, the application must also include:

1. a list of all or additional radionuclides to be used within the laboratory,
2. the maximum radionuclide activity possession limits for each isotope,
3. a description of the areas in the laboratory where the radioactive materials shall be used,
4. a list of all radiation safety equipment available,
5. a list of all radiation detection devices,

6. exact details on how radioactive materials shall be stored, and
7. exact details on how the laboratory shall handle radioactive waste.
8. In addition, the applicant must describe how the radioactive material will be used within an experiment. Therefore, the application must contain:
    a. A brief list of the experiments to be performed within the laboratory which use radioactive material,
    b. a list of the radionuclides used for each experiment along with an estimate of the amount of radioactive material used per experiment,
    c. an estimate of the frequency of each experiment

Before conducting any experiments involving radiation sources within the laboratory, the applicant must receive written authorization from either the Chairman of the Radiation Safety Committee, the Director of Radiation Safety, or their designee stating that they have been accepted by the Radiation Safety Committee as an Authorized User.

The Radiation Safety Committee has granted the Reactor Safety Subcommittee the authority to approve applications to become an Authorized User of the Research Reactor and the Accelerator Safety Subcommittee the authority to approve applications to become an Authorized User of the 5.5 MV Van-de-Graaff Accelerator.

Responsibilities of an Authorized User:

Authorized Users (AU) are responsible for implementing radiation safety rules, regulations, and procedures within their assigned radiation laboratory and are directly responsible for the following laboratory safety issues:

1. The AU is responsible for the safety of each person within the AU's assigned laboratory.
2. The AU is also responsible for assuring compliance with UML, state, and federal rules and regulations regarding radioactive materials or radiation emitting devices.
3. The AU must verify that radioactive materials are properly purchased, stored, used, and disposed.
4. The AU must assure that appropriate records documenting the safe use of radioactive material and radiation emitting devices are maintained by the laboratory. 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 and, if necessary, radiation field survey reports,
    c. documentation of final disposition of radioactive sources,
    d. memos documenting radiation related issues within the laboratory.

5. Authorized Users are responsible for having their laboratory members trained in specific radiation safety procedures and techniques practiced within the laboratory. This is in addition to the introductory radiation safety training provided by the Radiation Safety Office.

Reauthorization:

Authorized users must be reauthorized by the Radiation Safety Committee on an annual basis. Before reauthorization, the RSO must certify that the authorized user is in compliance with this Safety Guide.

Radiation Workers

Persons working under an Authorized User must follow the policies and procedures as outlined in this guide. They must use radiation sources only under the supervision of the Authorized User 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 basic radiation protection training by a member of the Radiation Safety Office and must receive on site laboratory training by the laboratory authorized user or his/her designee.

Becoming a Radiation Worker:

1. Individuals who desire to work with radiation sources or work in areas where radiation sources will be used are required to complete basic radiation protection training offered by the Radiation Safety Office. Call the Radiation Safety Office (x3372) to schedule training.

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

   - Basic radiation science.
   - Radiation risk, protection, and safety.
   - The concept of ALARA (As Low As Reasonably Achievable).
   - Federal, state, and university rules and regulations.
   - The responsibilities of the radiation worker, the authorized user, and the UMass Lowell 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 laboratory's Authorized User or designee.

Responsibilities of a Radiation Worker:

Any individual at UMass Lowell who works in an area where radiation sources or devices are used or stored is considered a radiation worker. Radiation workers at the university are responsible for:

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

2. Being trained by the laboratory's Authorized User (or designee) on specific radiation safety practices within the laboratory.

3. Following the UMass Lowell 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 4).

4. Wearing appropriate radiation monitoring devices such as film badges, ring badges, pocket ion chambers, etc…

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 V.

8. Performing a radiation survey, documenting the survey, and placing the survey results on file (see Appendix VII to learn how to perform a survey):

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.
d. after packaging or unpackaging a radiation source.

9. Immediately cleaning up contaminated areas and reporting spills and skin contamination to the Radiation Safety Office as soon as reasonably possible.

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 an Authorized User or a member of the Radiation Safety Office if you are unsure of a radiation safety related issue.

Section 4

RADIATION SAFETY REGULATIONS AND POLICIES

This section describes fundamental regulations, policies, and procedures on which this guide and the radiation safety program are based. 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 NRC and state licenses 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, 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 Policy and Procedures:

The University of Massachusetts Lowell, as licensee for the possession and use of radiation sources, recognizes its responsibility to both the Nuclear Regulatory Commission and the Commonwealth of Massachusetts to establish appropriate policies and procedures for the safe use of radiation sources. To this end the University has appointed a Radiation Safety Committee (See Appendix I) to develop such policies and procedures. This committee is directly responsible to the Chancellor in all matters of radiation safety.

The Committee has established in this Radiation Safety Guide the policies and regulations to be followed by all users at the University. Any additions or modification of procedures remain the responsibility of the Radiation Safety Committee. 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. Specific procedures on Radiation Safety are found in Part II of this guide.

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

UMass Lowell Radiation workers shall conform to the safety limits specified in Title l0 Part 20 of the Code of Federal Regulations and Massachusetts regulation l05CMR120 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 10CFR20.1003). 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/week. Exemptions to this administrative limit may be granted by the Director of Radiation Safety or his designee for specific projects on an as needed basis. Radiation sources normally encountered in the various activities at the University are not expected to cause individuals doses above this administrative limit. In fact, exposures are expected to be well below this limit. Planned exposures above this level must be pre-approved in writing by the Radiation Safety Officer and the individual's supervisor.

In addition, members of the public are limited to no more than 0.1 rem/year from radiation related activities performed at this university.

Offsite use of Radioactive Materials:

Radioactive Materials may only be used at authorized locations ("radiation labs") within the University of Massachusetts, Lowell in Lowell, MA. An exception to this rule is that radioactive sources exempt under the regulations of 10CFR20 part 30.71(A) and (B), and 105CMR120.195 Appendix A and B may be used for training, education, or research purposes at temporary job sites within the United States.

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 UMass Lowell 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 Radiation Safety Committee for such tasks and must have at least one Authorized User to accept responsibility for enacting the requirements of this manual.

2. Ordering and purchasing radiation sources are controlled through the Radiation Safety Office. 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 5

AUTHORIZATION TO USE RADIATION SOURCES

General Requirements:

Authorization to operate laboratories in which radiation emitting sources will be used is obtained from the Radiation Safety Committee prior to receiving possession of the radiation source. Individuals who work with radiation sources must either obtain specific approval from the Committee to use such sources or perform their activities under the supervision of an Authorized User. An Authorized User must be a member of the UML faculty, staff, or UML Research Foundation[1]

Applications for radiation source authorization must be submitted to the Radiation Safety Office. The Director of Radiation Safety is delegated authority by the Radiation Safety Committee to authorize uses of a routine nature. Similarly the Reactor and Accelerator Safety Committees are the delegated authorities to authorize non-routine (previously unreviewed) uses of their respective facilities. An application form is included in Appendix IX of this guide.

Application for Authorization to Procure, Use or Dispose of a Radiation Source:

An application form (Form HP-1, Appendix IX) must be properly filled out by the person desiring to procure, use, or dispose of a radiation source. Written authorization is granted for a specific radionuclide, quantity, and use and shall not apply to activities not specified on the authorization form. Authorizations are valid only for the period of time specified on the application. Similar activities to be conducted at a later date will require a new application or renewal. Authorizations will be issued for periods of time not to exceed one year; however, authorizations may be renewed if there are no significant changes in the user's program.

Approval of Applications:

Applications for the procurement, use, or disposal or a radiation source shall be submitted to the Director of Radiation Safety. The DRS will review the application and, may act to submit the application to the Radiation Safety Committee or delay action on the application if the DRS decides that the application must be reviewed by either a

[1] Authorized Personnel: In reference to all procedures for the operation of the accelerator, authorized persons are those persons who have satisfactorily completed a training program with the Accelerator Engineer and who have been approved by the Accelerator Safety Subcommittee. *See exceptions in Appendix III, Requirements for Authorization, Item 1.

subcommittee or Ad Hoc committee review prior to submittal of the application to the RSC. If an applicant has his/her application denied by the Director of Radiation Safety, he may appeal this decision to the Committee. The Radiation Safety Committee may delegate authority to the DRS to approve certain applications.

Amendment to Authorization:

Significant changes in the procedures or protocols specified in an Authorized User's application to supervise and use radiation emitting sources will require an amendment. Amended uses may not be implemented until authorization is received by the Radiation Safety Committee. Amendments in an Authorized User's authorization to procure, use or dispose of radiation sources shall be submitted to the Director of Radiation Safety.

Section 6

Purchase of Radioactive Materials and Devices

Introduction

A mutually convenient arrangement between the Purchasing Office and the Radiation Safety Office will prevent the accidental purchase and use of radioactive material by persons not familiar with the requirements of this Radiation Safety Guide.

Purchasing

Please review Section 5 prior to purchasing any radioactive materials. All radioactive material and device purchases must first be approved by the laboratory's Authorized User and then approved by either the Radiation Safety Office or Radiation Safety Committee as described in Section 5. This approval must occur prior to the submittal of a purchase requisition to the Research Foundation.

NOTE: The use of "procards" to purchase radioactive materials or radiation emitting devices is strictly prohibited.

When creating a purchase order, please note that all radioactive material and radiation emitting devices must be shipped to the following address:

Hazardous Materials stock room
201 Riverside Ave.
Lowell, MA 01854
Attention: Radiation Safety Office

Purchasing Procedure

The specific steps necessary to purchase radioactive materials or radiation emitting devices include:

1. Send a Radiation Purchase Request Form (Form HP-1, Appendix IX) to the Radiation Safety Office.
2. The Radiation Safety Office (RSO) can immediately approve previously reviewed experiments and uses of radioactive materials. New experiments or uses will be reviewed by the Radiation Safety Committee (RSC) at their next meeting.
3. If the purchase is approved by the RSO / RSC, the signed form will be sent / Faxed back to the user.

4. The user then writes the purchase order. *NOTE: The purchase order must have the order shipped to the Hazardous Materials Stock Room at 201 Riverside Ave, Attention Radiation Safety Office*
5. The user sends the signed Radiation Purchase Request Form along with their purchase order to the Research Foundation.

NOTE: The Research Foundation will not process purchase requisitions containing radioactive material unless a Radiation Purchase Request Form is present and signed by either a member of the Radiation Safety Office or a member of the Radiation Safety Committee.

Package Receipt

When the package is shipped to the university, the Radiation Safety Office will receive, open, inventory, and process your radioactive materials package. After processing, a member of the Radiation Safety Office will contact your laboratory to arrange a pickup.

The Radiation Safety Office will check all radioactive material packages 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 Radiation Safety Office 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 Radiation Safety Office*
- *The radioactive material container is visibly damaged*

All packages containing loose radioactive material (liquid, solid, gaseous) should be accompanied by a Radioisotope Use and Disposal Record (see Appendix IX) provided by the Radiation Safety Office. This form may be used as documentation for radioactive material inventory and waste. Users should use this form to document each time that the radioactive material is removed from the isotope stock container and record the final disposition of the material. If the form was not included with the package, call the Radiation Safety Office (x3372).

Section 7

Working with Radioactive Materials and Devices

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), labeled, and the location posted with a "Caution Radioactive Material" or “Caution Radiation Emitting Device” sign. The Radiation Safety Office will provide the laboratory with the proper signs and documentation to ensure compliance with the posting requirements of l0 CFR 20 and 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 AU-1 is recommended for recording the above information may be obtained from the Radiation Safety Office.

The following inventories are required:

1. an annual inventory to be submitted to the Radiation Safety Officer by all Authorized Users,

2. an annual physical inventory of all radiation sources to be conducted by the Radiation Safety Office with assistance from all Authorized Users.

3. For purposed of material accountability, Special Nuclear Material inventories are conducted at six month intervals by the Radiation Safety Office and the Reactor Operations group.

Labeling

Each individual radiation source (or container, if appropriate) shall be labeled with an identification tag clearly indicating the date, radionuclide (if applicable), quantity, and radiation or contamination level. Labels are available from the Radiation Safety Office. All tags or labels should be removed / replaced when the information on them is no longer applicable. Radioactive materials meeting the exemption criteria of 10 CFR 30 Appendix B and 105CMR129.297 do not need to be labeled. Call the Radiation Safety Office for questions on the labeling of radiation sources.

Occupational Radiation Exposure Limits (reprinted from section 4)

UMass Lowell Radiation workers shall conform to the safety limits specified in Title l0 Part 20 of the Code of Federal Regulations and Massachusetts regulation l05CMR120 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 10CFR20.1003). 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/week. Exemptions to this administrative limit may be granted by the Director of Radiation Safety or his designee for specific projects on an as needed basis. Radiation sources normally encountered in the various activities at the University are not expected to cause individuals doses above this administrative limit. In fact, exposures are expected to be well below this limit. Planned exposures above this level must be pre-approved in writing by the Radiation Safety Officer and the individual's supervisor.

In addition, members of the public are limited to no more than 0.1 rem/year from radiation related activities performed at this university.

Contamination control

Radioactive contamination control is practiced by 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 accordingly.

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. Alpha emitters and volatile radioactive compounds will be stored in sealed containers.

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.

Control Zones

Control zones will be established for controlling movement of radiation sources and personnel. These zones will protect personnel and property from 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 control zones are designated as follows:

1. A restricted 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 millirems 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 millirems 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 CFR20.l60l.

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

Type of Radiation	Removable Contamination Limits (dpm/l00 cm^2)
Beta (except tritium)	500
Tritium	1000
Alpha	50

Radiation Monitoring

Routine radiation and contamination monitoring surveys are conducted by the Radiation Safety Office as part of good radiation safety practice and to ensure compliance with our license requirements as described in Appendix II.

To protect both the radiation worker and members of the public, laboratories are required to perform radiation area and contamination surveys designed to characterize any radiation fields within the laboratory and identify potential contamination areas.

The laboratory Authorized User shall ensure that radiation surveys are performed when appropriate and that the survey results are properly recorded.

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 VII of this manual or may contact a member of the radiation safety office.

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

1. Radiation and contamination surveys (as applicable) when a radiation source 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 packaging or unpacking a radiation source.

4. After a radioactive material spill.

A log of the surveys and an inventory of material shall be kept by each Authorized User. Form AU-2 is a generic survey form recommended for use in campus radiation laboratories. A copy of this form is included in Appendix IX.

Records

It is a legal requirement of our state and federal radioactive material licenses 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 Radiation Safety Committee requires that the following information be recorded:

1. The Authorized User shall:
    a. keep an inventory of radiation sources and waste disposals (recommended form: AU-1),
    b. keep a record of contamination and radiation surveys made (recommended form AU-2).

2. The Radiation Safety Office 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 Radiation Safety Committee 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 and NRC regulations.

Section 8

Disposition of Radioactive Materials and Devices

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 Radiation Safety Office.

Radioactive materials may be transferred only to another Authorized User, either at the University or another institution. 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 Radiation Safety Office to work with the other institution's Radiation Safety Office and complete the appropriate paperwork. Authorized Users who may need to ship radioactive material frequently may be trained in the Radiation Safety Office procedure HPP-3: "Shipment of Radioactive Material" to obtain a degree of autonomy in radiation shipments.

Radioactive Waste

The University of Massachusetts Lowell is required under federal and 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 Radiation Safety Office should be contacted immediately (x3372) 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 day) 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. The Radiation Safety Office is available to assist in finding vendors of approved radioactive waste containers.

4. Regardless of the *type* of radioactive waste generated, all radioactive waste shall be assembled in designated restricted areas and stored in waste containers clearly labeled with the following: *"RADIOACTIVE WASTE."* The Radiation Safety Office 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 ***and*** the requirements for chemical/hazardous material waste handling as documented by the Environmental Health and Safety (EH&S) department.

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 Authorized User to assure that this list is promptly and accurately maintained.

7. When in use, a radioactive waste container shall be labeled with the following information:
    a. "RADIOACTIVE WASTE" warning sign
    b. Listing of the radioisotope(s) present within the container
    c. Chemical form(s) of the radioisotope(s) present (if liquid)

8. When full, a radioactive waste container shall be labeled with the following information:
    a. "RADIOACTIVE WASTE" warning sign
    b. Listing of the radioisotope(s) present within the container
    c. Estimate of the Activity present of each radioisotope (preferably in mCi)
    d. Chemical form(s) of the radioisotope(s) present
    e. Authorized User's name
    f. Laboratory room number
    g. Name of person labeling the waste
    h. Date that the waste was labeled

9. 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

Authorized User to verify that the location of the waste receptacle within the laboratory does not present a health hazard.

10. When a radioactive waste container is full, call the Assistant Radiation Safety Officer (x3373) to arrange a waste pick-up. NOTE: the Radiation Safety Office will not accept possession of any waste containing contaminated glass *unless* it is stored in a plastic lined rigid container (plastic, cardboard).

11. It is the responsibility of the Authorized User to verify that the waste is properly contained and identified. The Radiation Safety Office has the right to refuse waste pickup for improperly stored waste. The Authorized User also is responsible for ensuring that any improperly stored waste (especially waste refused for pickup) is properly repackaged *as soon as possible*.

12. Short-lived waste may be stored on site for decay until the activity of the waste is indistinguishable from background (the waste measures less than 2x the average background value in a low background area using an appropriate radiation detector).

    a. When the radioactive waste is indistinguishable from background, the Authorized User (or laboratory representative) shall contact the Radiation Safety Office. The Radiation Safety Office shall analyze the waste to certifiy that the waste is no longer radioactive.

    b. If the waste is no longer radioactive, it shall be disposed of as per the rules and regulations of the UMass Environmental Health and Safety Office (x2618) and all radioactive material labels on the container must be defaced or removed.

B. Solid Waste Handling Rules

1. Solid (dry) radioactive waste (gloves, absorbent material, etc…) shall be stored in plastic lined waste baskets (including cardboard dry waste containers).

2. Each radioactive waste basket shall be identified with the magenta and yellow radiation symbol and the words: “RADIOACTIVE WASTE.”

3. 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 ($T_{1/2} \leq 120$ day) materials together. In all cases, materials added to a waste container shall be chemically non-reactive with both the container and its contents).

4. *The laboratory shall maintain a list of the isotope(s) 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.

5. While in use, each radioactive waste basket shall be clearly labeled with the information required in Section A: General Waste Handling, Part 7. Verify that this information is not obscured from view.

6. Radioactive waste placed in dry waste boxes 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.

7. 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.

8. 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 properly sealed. Charcoal felt may be purchased to assist with the control of iodine volatility. Please call the Radiation Safety Office (x3372) if you have any questions on this matter.

9. When the container is full, the waste basket shall be labled to clearly display the information required in Section A: General Waste Handling, Part 8. Verify that the label is not obscured from view.

10. After labeling a full waste container, call the Assistant Radiation Safety Officer (x3373) to arrange a pickup. NOTE: the Radiation Safety Office will not accept possession of any waste containing contaminated glass *unless* it is stored in a plastic lined rigid container (plastic, cardboard).

11. Short-lived solid waste may be stored on site for decay until the activity of the waste is indistinguishable from background (the waste measures less than 2x the average background value in a low background area using an appropriate radiation detector).

    c. When the radioactive waste is indistinguishable from background, the Authorized User (or laboratory representative) shall contact the Radiation Safety Office. The Radiation Safety Office shall analyze the waste to certifiy that the waste is no longer radioactive.

    d. If the waste is no longer radioactive, it shall be disposed of as per the rules and regulations of the UMass Environmental Health and Safety Office (x2618).

C. Liquid Waste Handling Rules

1. Liquid radioactive waste (including liquid scintillation fluid) shall be contained in plastic or glass, sealable jugs. Call the Radiation Safety Office (x3372) if special consideration must be given to another type of container due to chemical incompatibility with plastic or glass approved containers. NOTE: Liquid radioactive waste should be doubly protected. Plastic storage bins are therefore available from either the Radiation Safety Office or the Environmental Health and Safety 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 $T_{1/2} \leq 120d$) 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 Section A: General Waste Handling, Part 7. Verify this information is not obscured from view.

5. *The laboratory <u>shall</u> 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 liquid radioactive waste container is nearly full, attach a Radioactive Material Tag to the container including the information documented in the General Radioactive Waste Handling section, part 8. Verify that the label is not obscured from view.

7. Call the Assistant Radiation Safety Officer (x3373) to arrange a pickup

8. Short-lived liquid waste may be stored on site for decay until the activity of the waste is indistinguishable from background (the waste measures less than 2x the average background value in a low background area using an appropriate radiation detector).

    e. When the radioactive waste is indistinguishable from background levels of radiation, the Authorized User (or laboratory representative) shall contact the Radiation Safety Office. The Radiation Safety Office shall analyze the waste to certifiy that the waste is no longer radioactive.

f. If the waste is no longer radioactive, it shall be disposed of as per the rules and regulations of the UMass Environmental Health and Safety Office (x2618).

9. *Organic based Liquid Scintillation cocktails containing ^{3}H or ^{14}C at concentrations below 0.05 μCi/ml (1.11×10^{5} dpm/ml) may be disposed of as toxic waste without regard to radioactivity (that is, it is considered non-radioactive)*. Call the Environmental Health and Safety Office for further information.

10. Disposal of *aqueous* liquids via a designated radioisotope laboratory sink may be performed only if the laboratory meets the following criteria:

    a. the isotope concentration falls within the limits documented in the UMass Lowell Radiation Safety Manual (Appendix IX) and 10CFR20 App. B, AND,
    b. The waste is an aqueous solution AND
    c. The Authorized User has been previously approved by the Environmental Health and Safety office (EH&S) for sink release for the specific chemical in question. Approval may be obtained by submitting a "Non Hazardous Waste Determination Form" to the EH&S office. Contact EH&S for more information

***NOTE**: The Radiation Safety Office shall be notified of all sink disposals prior to disposal.*

11. The Authorized User is responsible for maintaining records which document the total activity disposed via the sink disposal route, the isotope disposed, the date, liquid volume, and the activity concentration of the solution. NO permit holder may dispose of more than 100 μCi per day through the sanitary sewer system without prior approval of the Radiation Safety Office.

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 **NOT** contain:
    a. Needles
    b. Syringes
    c. Knives
    d. Blades
    e. Glass
    f. Sharps
    g. Polyvinyl chloride plastics

h. Scalpels
i. Pipettes
j. Ceramics.

3. Once the animal carcass has been double bagged, it must be frozen for at least twenty four to forty eight hours prior to pickup by Radiation Safety.

4. Short-lived animal carcass waste may be stored on site for decay until the activity of the waste is indistinguishable from background (the waste measures less than 2x the average background value in a low background area using an appropriate radiation detector).

   g. When the radioactive waste is indistinguishable from background, the Authorized User (or laboratory representative) shall contact the Radiation Safety Office. The Radiation Safety Office shall analyze the waste to certifiy that the waste is no longer radioactive.

   h. If the waste is no longer radioactive, it shall be disposed of as per the rules and regulations of the UMass Environmental Health and Safety Office (x2618).

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

6. Call the Assistant Radiation Safety Officer (x3373) 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 $T_{1/2} \leq 120d$) 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 Section A: General Waste Handling, Part 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 Authorized User to assure that this list is promptly and accurately maintained.

6. Short-lived sharps waste may be stored on site for decay until the activity of the waste is indistinguishable from background (the waste measures less than 2x the average background value in a low background area using an appropriate radiation detector).

    i. When the radioactive waste is indistinguishable from background, the Authorized User (or laboratory representative) shall contact the Radiation Safety Office. The Radiation Safety Office shall analyze the waste to certifiy that the waste is no longer radioactive.

    j. If the waste is no longer radioactive, it shall be disposed of as per the rules and regulations of the UMass Environmental Health and Safety Office (x2618).

7. When the sharps radioactive waste container is full, attach a Radioactive Material Tag to the container including the information documented in the General Radioactive Waste Handling section, part 8. Verify that the label is not obscured from view.

8. Call the Assistant Radiation Safety Officer (x3373) to arrange a pickup.

F. Lead Shipping Containers

Many stock vials are shipped from vendors within lead (Pb) shielded containers. These containers may be given to the Radiation Safety Office or may be disposed of by the laboratory. Non-contaminated lead shields may be disposed of as per the rules and regulations documented by the UMass Environmental Health and Safety Office (x2618). Any lead shield contaminated with radioactive material shall be either labeled and stored as radioactive waste or labeled and given to the Radiation Safety Office.

APPENDICES

Appendix I: Committee Membership[1]

Radiation Safety Committee

Chairman: Clayton French, Professor, Radiological Sciences

Secretary: David Medich, Director Radiation Safety

Leo Bobek, Reactor Supervisor

Sue Braunhut, Biological Sciences

Nelson Eby, Professor, Environmental Earth & Atmospheric Sciences

Jerome Hojnacki, Dean, Graduate School

Gunter H. R. Kegel, Chairman, Accelerator Safety Subcommittee

Richard Lemoine, A. Director of Environmental Health & Safety

Robert Tamarin, Dean, College of Arts and Science

Accelerator Safety Subcommittee

Chairman: Gunter H. R. Kegel, Director, Radiation Laboratory

Secretary: David Medich, Director Radiation Safety

James Egan, Professor, Physics

Gregg Parker, Supervisor, Van de-Graaff Accelerator

Mark Tries, Assistant Professor, Radiological Sciences

Reactor Safety Subcommittee

Chairman: John White, Professor, Nuclear and Chemical Engineering

Secretary: David Medich, Director Radiation Safety

Leo Bobek, Reactor Supervisor

Mark Tries, Assistant Professor, Radiological Sciences

Gunter H. R. Kegel, Director, Radiation Laboratory

Mary Montesalvo, Radiation Laboratory

Nelson Eby, Professor, Environmental Earth & Atmospheric Sciences

[1] Committee List as of Se;ptember, 2005.

Appendix II: Radiation Safety Office Staff and Services

Staff (Nominal)

Dr. David Medich, Director Radiation Safety
Phone: x3372
Office: Pinanski 211

Steven Snay, Radiation Safety Technician
Phone: x3373
Office: Pinanski 213

Services

The following services shall be provided by the Radiation Safety Office for all authorized personnel at UML.

Personnel Monitoring

Appropriate personnel monitoring devices such as film badges, thermoluminescent dosimeters and/or pocket dosimeters will be assigned to each person and their use will be required for:

1. Entry to an area under circumstances such that an individual could receive in any month period effective whole body dose in excess of 40 mrem,
2. Entry to a high radiation area,
3. Any individual under eighteen or declared pregnant worker who may occupationally exposed to penetrating radiation.

Personnel monitoring records will be maintained by the Radiation Safety Office. The Radiation Safety Office will investigate any significant exposure readings (exposures greater than 10% of the regulatory limits listed in Table 1).

Storage areas will be provided by the Authorized User for all personnel monitoring devices when not worn. Individuals issued such devices will be required to leave these devices in the storage area when leaving work for the day. If a personnel monitoring device is lost or damaged a record of the incident will be made in order to document the period of time for which exposure data were lost.

Radiation and Contamination Surveys

Surveys will be conducted by a member of the Radiation Safety Office monthly for laboratories actively working with unsealed sources and weekly for laboratories actively using unsealed sources greater than l0 mCi. Non-active laboratories, in which radioactive material is stored, will be surveyed quarterly. Special monitoring can be requested by contacting the Radiation Safety Office. If any abnormal or hazardous conditions are noted during survey, the responsible person(s) will be notified immediately and remedial actions will be recommended.

Bioassays

Bioassays will be performed on all individuals performing iodinations with iodine activities (I-123, I-125, I-131) greater then 0.5 mCi or on those working with unsealed bound sources greater then l0 mCi. Bioassay shall take place within 7 days of the iodination or potential exposure.

Radiation Instrument Calibration

A facility will be maintained for the calibration of monitoring devices and survey instruments. All survey instruments in use will be calibrated at intervals not to exceed 12 months. Requests for instrument calibrations should be made to the Radiation Safety Office.

Consultant Services

The Radiation Safety Office will discuss any matter relative to radiation safety. It will also provide advice and assistance on the design of radiation experiments, radiation facilities, and on the purchase and use of radiation detection instrumentation.

Transportation and Shipping Assistance

Advice and assistance on transportation and shipping regulations will be provided for shipment of any radiation source. Radioactive materials must be checked by the Radiation Safety Office prior to shipment. Appropriate labels will be affixed to the package. This will help to prevent contamination problems and insure compliance with Federal transportation regulations. Any transportation or delivery of radioactive materials must be in accordance with title l0 CFR 71.

Emergency Assistance

If a situation arises whereby radiation safety has been compromised, or a potential hazard exists contact the Radiation Safety Officer immediately (X3372, X3373). When a problem arises after hours, call the Campus Police (X29ll) who will notify individuals on the emergency call list.

Radiation Safety Training

The Radiation Safety Officer conducts a training program for all radiation workers or others who frequent areas where licensed material is used. The training is tailored to the category of worker and the type of work that they will be performing. Radiation Laboratory workers are required to attend a six-hour course or equivalent on the above subjects. All radiation workers and authorized users are required to attend a one-hour refresher seminar every two years. Specific training is provided to maintenance and other ancillary personnel who are required to work in areas where radiation sources are used or stored. Record of all initial and refresher courses, including topics, students, instructors, dates and the length of the training are maintained by the Radiation Safety Office.

Appendix III: 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 before handling any object which goes to the mouth, nose, or eyes. Keep fingernails short and clean.
Pipetting	Never pipette anything by mouth.
Protective Clothing	Always use rubber or plastic 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 over lined absorbent material, preferably on a tray. Radioactive materials that are being transported should be doubly contained.
Spills	Notify the Radiation Safety Office 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.

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.
Sample Analysis	Take only prepared samples into the sample analysis area. No potentially contaminated material is permitted in the RSO counting room.
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 hazard.

Regulations and Procedures for Specific Facilities and Sources

The Van-de-Graaff Accelerator

General Information:

The Van-de-Graaff Accelerator is a 5.5 MeV direct current positive ion accelerator used for research and training in the fields of Nuclear Science and Engineering. The particle accelerator is part of the Radiation Laboratory and operated on a full time basis.

All persons who desire to become an accelerator operator must first become familiar with its operation and potential hazards. Those individuals who plan to operate the accelerator must satisfactorily complete a training program conducted by the Accelerator Supervisor or his designee and must be approved by the Accelerator Safety Subcommittee as an accelerator operator. Any individual not authorized to operate the accelerator must work under the direct supervision of an authorized accelerator operator.

The Radiation Safety Office will conduct radiation surveys in the experimental work area to determine radiation levels and assess the overall radiological safety of the work area for all new experiments. All survey results will be maintained by the Radiation Safety Office.

The Accelerator Safety Subcommittee shall review all authorizations, changes in procedures, review of experimental work, and special accelerator related issues.

Operating Procedures and Conditions for the UMass Lowell Van-de-Graaff Accelerator

a. Accelerator Start-up procedures
   i. Only those persons who have been authorized to operate the accelerator will have access to the key necessary to start the drive motor.
   ii. Two persons from the accelerator staff will be in the accelerator control room, one of which shall be an accelerator operator and must remain in the accelerator control room at all times once the drive motor is engaged[1].
   iii. A physical search and survey of the target and accelerator rooms will be carried out by the accelerator staff with the results reported to the accelerator operator.
   iv. If the experiment protocol requires cooling the target with water, a visual check of the target cooling water flow will be made with the results reported to the accelerator operator.

[1] Under certain conditions specified by the Accelerator Safety Subcommittee, the accelerator may be operated by a single authorized individual. Under these circumstances the accelerator operator is prohibited access to the target room. Target room access during accelerator operations shall only be permitted when two or more accelerator personnel are present

v. The basement entrance doors and the accelerator room gate interlocks will be checked (See section IV, items 1 and 2 and posted floor plans) with the results reported to the accelerator operator.
vi. Once all systems have been verified to be functional and the accelerator target and tank rooms verified to be free of unauthorized individuals, the accelerator operator will insert the drive motor key into the console and start up the accelerator. Upon initiation, a Klaxon horn, located in the target room and audible throughout the accelerator facility, will sound continuously for several seconds prior to starting the drive motor for accelerator startup.
vii. Lighted signs bearing the warning "Caution, High Radiation Area" posted over all entrances to the target room and tank room will remain on while the drive motor is energized.

b. Accelerator Operations
i. The accelerator console operator shall have quick access to the accelerator control room at all times.
ii. The console operator shall be responsible for visually monitoring and controlling access into the target room during accelerator operations.
iii. Entrance into the accelerator target room during accelerator operations shall conform to the procedures controlling entrance into a potential high radiation area within the accelerator facility (section c):

c. Regulations Regarding Entrance to Potential High Radiation Areas within the Accelerator Facility
Depending on the type of target used and the accelerator operating current, the Tower Room and the Target room are potentially high radiation areas during accelerator operations. Therefore the following safety procedures shall be followed by all personnel:

i. Only individuals authorized by the Accelerator Safety Subcommittee shall enter the accelerator target room or tower room during acceleration operations (referred to as the HRA technician). The accelerator facility shall maintain a list of those individuals authorized for such entry.
ii. If access to a potentially high radiation area is desired during accelerator operations, a minimum of two accelerator personnel must be present with at least one person remaining in the accelerator control room.
iii. Prior to entry into these rooms, the authorized HRA technician is required to wear full radiation dosimetry including a whole body film badge and a hand/finger badge.
iv. The accelerator operator shall maintain constant communication with the authorized technician at all times while the person is within the target/tower room.
v. Before entering the target/tower room, the HRA technician will survey the entrance area with an appropriate survey instrument to verify that the radiation fields are within expected levels.

vi. If radiation levels outside the entrance of the target/tower room are detected that are higher than those normally found under similar operating conditions, the HRA technician shall leave the area and alert the Radiation Safety Officer.
vii. While inside the target/tower room, the HRA technician will survey the working area with an appropriate survey instrument to verify that the radiation fields are within expected levels.
viii. If radiation levels inside the target/tower room are detected which are higher than those normally found under similar operating conditions, the HRA technician shall leave the target/tower room and alert the Radiation Safety Officer.
ix. After work in the room is complete, the HRA technician shall return to the control room and report to the console operator.

d. Accelerator Shut-down
i. The accelerator will be turned off by cutting power to the belt drive motor, thus preventing further emission of radiation, except from activated components.
ii. If all conditions appear normal, entrance into the accelerator target room will be made by personnel authorized by the operator.
iii. Any emergency condition shall be handled as outlined under the Emergency Plan.
iv. The cooling water will be checked.
v. The drive motor key will be removed.

e. Alarms and Safety Devices Incorporated in the Accelerator Complex.
i. Failsafe electrical interlocks are positioned on all radiation area entrances not under the visual control of the console operator. These interlocks will automatically shut down the machine upon room access.
ii. The doors accessible in the control room which lead to the accelerator tank and target rooms are electro-mechanically interlocked such that, if opened during machine operations, an alarm will sound in the control room.
iii. The target room entrance is posted with the warning, “CAUTION, HIGH RADIATION AREA”. This sign will be lighted during accelerator operations.
iv. A red warning light in the target room will be lighted during operations.
v. Neutron and gamma radiation levels in the target room will be monitored remotely at the accelerator console.
vi. Emergency shutdown switches are located in both the target room and accelerator room.
vii. A warning Klaxon horn will sound in the control room prior to accelerator start-up.
viii. Vacuum pump interlock switches will shutdown the machine if the vacuum system fails.

One Megawatt Swimming Pool Reactor

General

The UML Nuclear Reactor is water cooled and operates at a maximum power level of one megawatt. It is used primarily for training and research in the fields of nuclear science, radiochemistry and engineering. The reactor is housed in a containment building which is part of the UML Radiation Laboratory.

Entrance to the reactor is restricted to those persons authorized to work in the facility. Unauthorized individuals must be escorted by authorized personnel.

Authorizations, changes in procedures, review of experimental work, production of radioisotopes, and special problems involving the reactor facility will be taken up by the Reactor Safety Subcommittee.

Operating procedures and conditions for the reactor

a. Only persons licensed by the Nuclear Regulatory Commission or who are working under the direct supervision of a licensed operator will be permitted to operate the reactor.

b. Routine and emergency procedures shall be maintained and accessible to reactor personnel. Procedural changes must be reviewed and approved by the Reactor Safety Subcommittee as required by the reactor operating license.

c. The operation of certain continuous monitoring equipment which monitors the radioactivity levels or radiation levels of the stack effluent, liquid coolant, and general work environs is required for reactor startup and operation. Surveys and analyses will be conducted by the Radiation Safety Office to insure that working levels are within safe and permissible limits.

d. Individuals desiring to use the reactor and associated sample irradiation facilities must first apply for and receive appropriate authorization:

    1. Facility uses, such as experimental runs and setups, which have been previously approved by the Reactor Safety Subcommittee may be approved directly by the Reactor Supervisor and the Radiation Safety Officer.
    2. Reactor uses which have not been previously reviewed and approved by the Reactor Safety Subcommittee must be presented in proposal form to the Subcommittee for its review.

e. The Radiation Safety Office staff will survey the radiation levels and evaluate associated hazards during the initial startup of all new experiments to ensure safe operation.

f. The Radiation Safety Office staff will survey the radiation and contamination levels of all radioisotopes produced and removed from the reactor and any experimental equipment used in radiation facilities which might present a contamination or radiation hazard.

g. The Radiation Safety Office must be contacted prior to the removal of a radiation source from the reactor building (containment shell).

X-ray Machines

General

Authorization to purchase, store, use or dispose of an x-ray machine must be obtained from the Radiation Safety Committee or the Radiation Safety Officer. Certain instrumentation, machines, and devices (e.g., x-ray diffraction units, x-ray fluorescence systems, electron microscopes, etc.) may not be termed "x-ray machines" but, under certain conditions of operation, are capable of producing hazardous levels of x-radiation in the work area. Such devices, while not subject to the specific authorization requirements of this guide in so far as purchase or possession are concerned, are subject to the guide requirements relevant to use. Potential users of such devices are required to contact the Radiation Safety Office in order that appropriate surveys may be made and required protective action taken.

Procedures and conditions for operating an x-ray machine:

a. The Authorized User must notify the Radiation Safety Office prior to initial use of the machine so that a radiation survey may be made under operating conditions.

b. All personnel who use the x-ray machine must have adequate training in the proper use of the machine and be aware of the associated radiation hazards.

c. Persons using the machine must wear assigned personnel monitoring devices.

d. The Authorized User of the x-ray machine must notify the Radiation Safety Office of following situations:

   i A suspected exposure to radiation over administrative or regulatory limits,
   ii failure of a safety device related to machine operation or personnel safety, or
   iii Plans for making modifications of the x-ray machine.

Special Nuclear Material

General

Special Nuclear Material, which include (1) plutonium, uranium 233, uranium enriched in the isotope 233 or in the isotope 235, and (2) any material artificially enriched by any of the above, is considered a radiation source and must be handled in accordance with the requirements of this guide.

Specific requirements

a. All Special Nuclear Material will be stored and used in the Radiation Laboratory unless specific approval is granted by the Radiation Safety Office for use at other locations at UML. Reactor fuel will be stored in the reactor building or in an approved vault in the Radiation Laboratory.

b. Special Nuclear Material will not be combined or physically altered in any way to make a single source from several sources. Consideration will always be given to maintaining Special Nuclear Material in critically safe geometries. Use of the fuel in the reactor is obviously excluded from this consideration.

c. Leak tests and source inventories will be performed semiannually on all Specific Nuclear Material sealed sources (excluding reactor fuel).

d. The Control Procedures in Appendix IV and the Radiation Laboratory Rules in Appendix V will be applicable to the laboratory use of all Special Nuclear Material. The use of reactor fuel will be in accordance with the reactor license and specific operating procedures maintained by the reactor operations group.

e. Special security procedures apply to the possession and use of special nuclear material which do not apply necessarily to by product material. Such procedures will be made known to the user by the Radiation Safety Office and must be followed.

Nonionizing Radiation Sources

General

Certain devices, such as lasers and microwave generators, produce electromagnetic radiation with energies considerably lower than ionizing sources, such as x-rays and gamma rays. These nonionizing radiation sources are still able to produce biological damage. Such devices are therefore subject to control in their use to assure protection of individuals.

Special Requirements

a. Any individual who purchases or otherwise obtains a Class IIIb or Class IV laser for use at UML is required to notify the Radiation Safety Office.

b. The installation and operation of any laser will be governed by ANSI Standard Z 136. The RSO and the Non-Ionizing Radiation Safety Subcommittee will conduct periodic reviews of all class III and class IV laser facilities and operation.

c. While no specific registration procedure is required for a microwave or rf source, any device which is expected to produce or suspected of producing possibly hazardous levels of radiofrequency (RF) or microwave radiation should be brought to the attention of the Radiation Safety Office so that a proper review/survey of the device may be made.

d. Any other known or suspected sources of possibly hazardous nonionizing radiation should be reported to the Radiation Safety Office.

Appendix IV: 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. The Radiation Safety Officer and the facility supervisor should 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 Personnel. Warn other persons in the immediate vicinity and assist any persons who may be contaminated or injured.

If the situation requires additional assistance, emergency action personnel who have been notified of the situation will take over after this first phase of the accident. They will prescribe additional action to be taken and begin restoration to normal operating conditions.

2. MINOR SPILLS (Spills which result in dose rates < 5 mR/hr 30 cm from source and does not contains >10μCi volatile material):

1. NOTIFY: Notify the people in the area that a spill has occurred.
2. REPORT: Report incident to the Radiation Safety Office (x3372).
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 alpha and low-energy beta emitters, conduct wipe tests at the spill area. All survey records must be maintained by the Authorized User.

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. CALL FOR HELP: Notify the Radiation Safety Office (x3372) or the University Police (x2911) immediately.
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 Radiation Safety Office 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

During a loss of power, a laboratory which possesses radioactive material that must be maintained in a fume hood or stored in a refrigerated condition could result in the spread of airborne contamination. 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.

CONTACT INFORMATION: RADIATION SAFETY OFFICE

Director of Radiation Safety: Dr. David C. Medich
Office: Pinanski 211
Phone: Extension x3372

Radiation Safety Technician: Steven Snay
Office: Pinanski 213
Phone: Extension x3373

IN THE EVENT OF AN EMERGENCY: IF YOU ARE UNABLE TO REACH THE RSO, CALL THE CAMPUS POLICE EMERGENCY HOT-LINE: x2911 IMMEDIATELY.

Note: The Massachusetts Department of Public Health Radiation Control program maintains an emergency 24-hour telephone number: (617-427-2913) which may be used in the event that you are unable to contact either the Radiation Safety Office or University Police.

Emergency Plan for the UML Energy Center (Exclusive of the Nuclear Reactor)

Introduction

The objective of this emergency plan is to provide immediate and coordinated action in handling any emergency which might arise at the Radiation Laboratory, exclusive of the nuclear reactor.

Scope

The potential hazards and conditions which may be encountered vary so that the most effective control is provided by prompt and appropriate action by local personnel. If local efforts must be supplemented by Health Physics Personnel, Fire and Security Forces, and Plant Maintenance, there must be a high degree of coordination in their joint activities. This is accomplished through organization and a chain of command for coordinating the emergency procedures.

Assignment of responsibility

Each Department head is charged with the responsibility for establishing an Emergency Plan, as well as anticipation of potential emergencies to establish procedures to handle such emergencies. Although overall responsibility lies with each Director, the actual implementation of these plans is assigned to designated individuals in each department. Approval of all procedures involving health and safety as well as additions and/or deletions of same is given by the Radiation Safety Committee.

The succession of authority will be as follows:

(1) Supervisor in charge of a specific facility (i.e., Accelerator Supervisor, Laboratory Instructor),
(2) Supervisor's designated representative, and
(3) Senior Staff member present.

Evacuation Procedure (posted):

a. Affected areas will be evacuated on signal when:

(1) A high concentration of flammable and/or toxic gas is detected or suspected.
(2) A release of hazardous quantities of airborne radioactive material is detected (ref. l0 CFR 20).
(3) High radiation levels (other than normal operating conditions) are measured (ref. l0 CFR 20).
(4) A fire, explosion, or structural defect is noted.
(5) The facility becomes flooded.

b. During an evacuation, the following actions will be taken (to be posted):

(1) The facility and associated equipment will be shutdown at the same time the evacuation signal is activated.

(2) The supervisor or operator on duty will immediately contact the Radiation Safety Office and a senior staff member on duty. If necessary, request the service of fire and hospital facilities through the Campus Police.

(3) The supervisor or operator in charge will remain at the facility console to maintain communications with appropriate groups as long as safely possible.

(4) The second operator on duty or staff members present will insure that the persons evacuated are assembled at the designated assembly point.

(5) The supervisor and Radiation Safety Office personnel on duty will determine if it is safe to enter the affected area(s).

(6) Steps will be taken to reduce the spread of any contamination or toxicant released in the area.

A complete evaluation of the emergency and implementation of further action will be handled by the emergency team. This group consists of staff, operational personnel, and emergency team members. Their phone numbers will be posted at various locations in the Radiation Laboratory.

Appendix V: Guide for the Authorized User

Authorized User Checklist

Refer to this checklist regularly to ensure that your radiation protection program is in compliance with university, state, and federal requirements.

1) **Radiation Source Receipt**:

a) Verify that all radiation source purchases or receipts have been pre-approved by the Director of Radiation Safety (DRS) or the Radiation Safety Committee. *This includes sources for which payment is not required.*

b) Verify that all radioactive source to be shipped to the university are sent to:

Hazardous Materials Stock Room
201 Riverside Ave.
Lowell, MA 01854
ATT: Radiation Safety Office

2) **General laboratory safety compliance**:

a) All laboratory personnel working with or near radioactive material or radiation emitting devices have been trained in basic radiation safety by the Radiation Safety Office.
   i) Is the staff familiar with basic radiation physics:
      (1) alpha, beta, gamma radiation and their properties,
      (2) Activity and half-life,
      (3) radiation dose (rad, rem),
      (4) radiation protection (time, distance, shielding),
      (5) internal vs. external radiation exposure,
      (6) radioactive material contamination,
   ii) Is the staff familiar with their annual radiation dose limits?
   iii) What about ALARA? Is there a viable ALARA program within the laboratory and is it being followed?
   iv) Do female lab workers understand the concept of a declared pregnancy when working in a radiation lab?
   v) Do staff members understand when to survey the work area
   vi) And do they understand the importance of maintaining survey records
   vii) Does the staff properly record radioactive material use/disposal?
   viii) Does the staff know what to do in the event of a spill/emergency?

b) Have all laboratory personnel have been trained by a competent member of the laboratory in radioactive material use, storage, and disposal within the laboratory?

c) Does the laboratory maintain an accurate and up-to-date radioactive material inventory?
   i) Initial radioactive material receipt documented (form HP-1, for example),
   ii) radioactive use and disposal documented (see Checklist #5).

d) Verify that radioactive materials are properly used and stored in areas clearly

demarcated for radioactive material use.

e) Radiation Generating Devices such as lasers and x-ray machines are properly documented and properly and safely used by laboratory staff.

3) **Handheld radiation monitoring instrumentation**:

a) Verify that any hand-held radiation monitoring instrumentation is available and working.
b) Verify that the instrument has been calibrated by the Radiation Safety Office within the last 12 months.
c) Verify that the instrument is not damaged or malfunctioning (Battery check)
d) Verify that the instrument responds as expected to a radiation source or background radiation.
e) Do laboratory personnel check items a-d prior to using a held-held instrument?

4) **Laboratory Operations:**

a) Check that laboratory doors are posted with appropriate signs (Caution Radioactive Materials, Caution Radiation Area, etc.).
b) Assure that all radioactive material containers are properly labeled.
c) Verify laboratory members are wearing assigned dosimetry (if required).
d) Check that laboratory members wearing lab coats or other appropriate protective clothing, including safety glasses.
e) Assure that a complete laboratory survey is performed and documented at the end of each day in which radioactive material is used or accessed.
f) Make sure work with radioactive materials is ALARA.
g) Verify that radioactive materials are secured when not in use.
h) Lastly, check that members of the laboratory do not eat, drink, smoking or apply cosmetics in the laboratory, and do not mouth pipette.

5) **Radioactive Material Disposition:**

a) Radioactive waste or radioactive solution drawn from a stock solution must be documented for inventory purposes. The Radioisotope Use and Disposal Record should be used for this purpose. Other forms may be substituted but must be authorized by the Radiation Safety Office.
b) Obtain prior approval from the Radiation Safety Office for any transfers of radioactive materials;
c) Contact the Radiation Safety Office when a waste container becomes full.
d) Label all radioactive waste containers as required;
e) Do not place radioactive wastes in unlabelled containers or regular trash;
f) Deface "RADIOACTIVE" labels on all empty packages;
g) If you wish to dispose of radioactive material through the sink, verify that your laboratory is licensed with the Environmental Health and Safety Office for sink Disposals and that sink disposals are within the limits dictated within this guide. ***All Sink Disposals must be recorded*.**

Appendix VI: Guide for the Radiation Worker

Radiation Worker Guide

All radiation workers should periodically review the items listed in this guide to gauge their knowledge and understanding of our radiation safety program.

1. Am I familiar with my annual radiation exposure limits (dose limits) as dictated in federal regulation 10CFR20 and state regulation 105CMR120?
    a. *Whole Body: 5 rem/year*
    b. *Organ/skin: 50 rem/year*
    c. *Eye: 15 rem/year*

2. Have I undergone proper training for working in a radiation lab?
    a. Have I undergone through the mandatory initial basic radiation safety training session offered by the Radiation Safety Office?
    b. Have I been given an introductory safety tour by the authorized user or his/her designee to help me become familiar with specific laboratory safety and safety related procedures?
    c. Have I been trained in the procedures for which I am expected to perform?
    d. Do I need retraining in any of the above topics?

3. Am I familiar with the radioactive sources located within the laboratory?
    a. What isotopes are used in the laboratory?
    b. Are there any special safety concerns for any of these isotopes? (Example, tritiated water (^3H_2O) absorption through skin)
    c. Am I familiar with the experimental protocols for these isotopes?
    d. Have I been trained in the use of these isotopes?

4. Do I understand the requirements for using radioactive materials?
    a. Do I record the use or removal of radioactive material from a stock solution (Rad Use and Disposal Form, or equivalent)?
    b. Do I use or have available portable survey meters during an experiment[1] ?
    c. Do I wear proper dosimetry when applicable (film badge, ring badge)?
    d. Do I survey my work area at the end of each experimental work day?
    e. Do I document my survey and place the results on file?
    f. Do I properly handle any radioactive waste generated during the course of the experiment (as per HPP-5)?
    g. Do I document radioactive waste production as per HPP-5?

5. Am I familiar with the radioactive devices located within the laboratory?
    a. Where are the devices located

[1] Not applicable for tritium (^3H) use and not required for ^{14}C use.

   b. What are the safety protocols observed when the device is operational?
   c. If I am an operator of the device, have I been trained in its operation? Is the training documented (memo, etc…)?

6. Where are all radiation related records/documents kept?
   a. Area / contamination surveys
   b. Radioactive material inventory (e.g. Rad Use and Disposal Form or eqv't)
   c. Waste inventory
   d. Radiation related memos

7. Do I understand radioactive waste handling and storage procedures?
   a. Waste handling procedures specific to my laboratory
   b. Procedures required by HPP-5?

8. Am I comfortable in using a portable survey instrument? Do I:
   a. Check battery signal before use
   b. Check instrument response before use
      i. Check background response or rad. source response for GM
      ii. Check response to radioactive check source if ion chamber.
   c. Check to make sure that the instrument is calibrated and within its calibration period?
   d. Set the instrument to the proper meter scale (x1, x10, etc) and understand how to interpret the instrument response reading?

9. Am I familiar with the general laboratory emergency response procedures such as radioactive material spill handling, area decontamination, etc…?

10. Am I familiar with university controls for contaminated areas?
   a. Beta radiation – maximum 500 dpm per 100 cm^2 area.
   b. Alpha radiation – maximum 50 dpm per 100 cm^2 area.
   c. Tritium (special beta case) – maximum 1,000 dpm per 100 cm^2 area.
   d. Have I been instructed what to do if any of the above levels of contamination are exceeded?
      i. Alert the Authorized User and/or Radiation Safety Office
      ii. If not cleaned up, have the Radiation Safety Office post the area as a Contamination Area
   e. If I am working with radioactive material and I accidentally spill a small quantity of radioactive material onto my workplace, do I know how to properly clean /decontaminate the area?

11. Do I understand posting requirements for radiation fields?
   a. Radiation Area – 5 mrem/hr 30 cm or greater from a source
   b. High Radiation Area – 100 mrem/hr 30 cm or greater

12. Do I understand that I am responsible for the security of the laboratory and of the radioactive material used within?

Appendix VII: Guide for Performing Radiation Surveys

Introduction

Routine laboratory surveys are an important part of the UMass Lowell 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 Radiation Safety Office.

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. The following methods can be used to perform a survey:

1. Radiation Field Survey
2. Contamination (Wipe) Survey

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 Radiation Safety Office.

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 Radiation Safety Office 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 Authorized User of 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 each 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.

NOTE: All Radioactive spills or emergencies, unless minor, are to be reported to the Radiation Safety Office 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…

Radiation Emitting Device

If you are using an X-ray machine or other type of radiation emitting device, you should periodically perform a General Radiation Field Survey during machine operations to verify that the machine is operating as expected. If unexpected dose rates are measured, turn off the machine and inform the Authorized User or a member of the Radiation Safety Office.

Radioactive Sealed Source

Sealed sources are radioactive sources which have been encapsulated to prevent potential contamination. The Radiation Safety Office checks such sources for radioactive material leakage on a semiannual (6 month) basis. Similar to radiation emitting devices, users should periodically perform a General Radiation Field Survey for an exposed sealed source. If unexpected dose rates are measured, place the source back into its shielded storage container and inform the Authorized User or a member of the Radiation Safety Office.

Radioactive Material (solid, liquid, gas)

Due to potential contamination issues, laboratories using radioactive material are required to perform both contamination surveys and radiation field surveys. Excess radiation field or contamination results are to be reported to the laboratory Authorized User and Radiation Safety Office immediately. Note: radiation field surveys are not required when Tritium, ^{14}C, or other low energy beta sources are used which are essentially undetectable with any type of portable survey meter; contamination surveys for these isotopes, on the other hand, are required and must be performed using a detector, such as a liquid scintillator or gas flow proportional counter, that can detect these types of radiation.

How to Perform a Mandatory Radiation Field Survey

1. Documented radiation surveys are required:
    a. After each day of radioactive material usage/experimentation.
    b. After transfer of radioactive material from stock solutions.
    c. After each experimental run *if there is a possibility of a change in radiation levels or contamination.*
    d. After a minor radioactive spill or emergency.

2. Obtain a Radiation Survey Form (or your laboratory survey log book) and select appropriate areas within the laboratory to be surveyed. Pay special attention to areas surrounding radioactive sources, radiation work areas, and radioactive waste containers.

3. Select a detector appropriate for the type of radioactive source used. Typically an experimenter may use:
    a. A Geiger counter or Ion Chamber for general radioactive materials or radiation emitting devices.
    b. A Sodium Iodide (NaI) detector for low energy photon emitting isotopes (<60 keV) such as ^{125}I

4. Slowly move detector around survey area.
    a. Unexpected radiation fields are to be reported to the laboratory's Authorized User. The laboratory should attempt to determine the cause of the field and, if possible, the situation rectified or the radiation field shielded to bring the stray field to acceptable levels.
    b. Dose rates above 5 mR/hr (≥30 cm from source/shield) shall be reported to the Radiation Safety Office and the area properly posted.

5. Select at least 4-5 areas and record survey results
    a. Special attention should be given to surveying the immediate workspace, isotope storage or waste containers, and entrances.
    b. If area dose rates are below 5 mR/hr 30 cm from the source or from a shield (if typically used during an experiment) proceed as per normal routine.
    c. If dose rates are measured greater than or equal to 5 mR/hr 30 cm from the source or source shield, alert the Radiation Safety Office. The Radiation Safety Office will characterize the area and post appropriate Caution signs.

6. If you were not using tritium (^{3}H) or carbon-14 (^{14}C) and you observed results which were less than 2x background (as read on your meter in a low background area) you do not need to perform a swipe test.

7. Record results on a Radiation Survey Form.
    a. The survey report must be ***dated*** and include the surveyor's ***initials or signature*** and a ***representative drawing of the laboratory***.
    b. The survey report must be maintained by the radiation laboratory. Do not discard records without discussing with RSO first!

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 Mandatory 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.
   c. Alpha radiation - 50 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 Radiation Safety Office).
   b. Low energy beta, high energy beta – Liquid scintillation counter, gas flow proportional counter.
   c. Alpha radiation – gas flow proportional counter, liquid scintillation 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 Authorized User. In any case, alert the Radiation Safety Office 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. Record your results on your Radiation Survey Form.
   a. The survey report must be ***dated*** and include the surveyor's ***initials or signature*** and a ***representative drawing of the laboratory***.
   b. The survey report must be maintained by the radiation laboratory. Do not discard records without discussing with RSO first!

10. Once the contaminated area has been cleaned, perform one last recorded radiation contamination survey to prove and document that the area falls below the contamination limits described above.

Appendix VIII: 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 Radiation Safety Office 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 a 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 Radiation Safety Office.

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, itis normal to observe fluctuations on the meter scale use an average of the meter fluctuation. General background readings found in UMass Lowell buildings are usually from 30 – 150 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 Radiation Safety Office 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 IX: 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: HP-1: “Purchasing radioactive material or radiation emitting devices”
2) Form: HP-2: “Application to become an Authorized User of Radioactive Material”
3) Form: AU-1: “Radioactive Material Use and Disposal Record”
4) Form: AU-2: “Radiation survey results”
5) Rules and Regulations for Sink Disposal (*note: this form must be posted next to a sink approved by the Radiation Safety and EHS offices for radioactive materials disposal*)

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Sink Disposal of Radioisotopes

(NOTE: prior approval from the RSO and EHS offices is required)

Isotope	Maximum μCi/ml*	Concentration μCi/gal
C-14	3×10^{-4}	1.1
H-3	1×10^{-2}	3.7
P-32	9×10^{-5}	0.3
S-35	1×10^{-3}	3.7
I-125	2×10^{-5}	.07
I-131	1×10^{-5}	.035
Ca-45	2×10^{-5}	0.76
Ni-63	1×10^{-3}	3.7

Disposal via a designated radioisotope laboratory sink may be done only if the isotope concentration falls within these limits AND if the material is in an aqueous solution AND not otherwise hazardous.

Records must be maintained showing the total amount of material, the date, and concentration disposed of in this manner.

No permit holder may dispose of more than 100 μCi total isotopes per day through the sanitary sewer system without prior approval of the RSO.

Organic based liquid scintillation cocktails containing H-3 or C-14 at concentrations less than 0.05 μCi may be disposed of as toxic waste without regard to radioactivity. Again records must be maintained showing concentration, amount and date of disposal.

*These values are taken from 10CFR20, App. B, Table 3.