MOUNT HOLYOKE COLLEGE
Safety Handbook VII(a)

RADIATION SAFETY
POLICY AND PROCEDURE MANUAL
FOR RADIONUCLIDE USE

Mount Holyoke College
Environmental Health and Safety
538-2529

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APPENDICES

RADIATION SAFETY POLICY AND PROCEDURE MANUAL FOR RADIONUCLIDE USE

I. SCOPE

The policies and procedures contained in this manual apply to all departments, laboratories, and persons using and possessing radioactive material at Mount Holyoke College.

II. INTRODUCTION

Ionizing radiation is potentially hazardous unless used with strict adherence to safety rules and procedures. Unlike most other such hazards, the risks of unguarded exposure to ionizing radiation includes the possibility of damage to future generations.[1] Thus, the safety rules which govern all uses of ionizing radiation are concerned with preventing genetic damage as well as protecting the health of the exposed individual. When followed faithfully, these rules limit the exposure of persons who work with radioactive materials to levels far below those that are believed to cause any adverse effects. The rules and procedures set forth in this Manual have one single straightforward purpose; to protect employees and the public against unnecessary and potentially harmful exposure to ionizing radiation.

Four stages of responsibilities are involved in the Radiation Safety Program. All are equally important.

A. Radiation Safety Committee: This is a group of scientists and administrators appointed by Mount Holyoke College to establish policies and procedures governing the use of ionizing radiation at the College.

B. Radiation Safety Officer: Responsible for ensuring compliance with established College policies and procedures. He/She also provides a variety of technical services to the College community necessary for achieving and maintaining compliance. In the absence of the Radiation Safety Officer, the Assistant Radiation Safety Officer fulfills the duties of the Radiation Safety Officer.

C. Licensed Investigators: College faculty members whose training and experience are such that they have been authorized by the Radiation Safety Committee to use ionizing radiation in their research and educational activities. Licensed Investigators are responsible for all aspects of their laboratory's radiation safety compliance program.

D. Individual Users: Scientists, research personnel, students, technical and other workers engaged in laboratory research, research support, and educational activities which involve actual use or handling of materials and devices producing ionizing radiation. These users work under the immediate supervision of a Licensed Investigator.

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[1] Information on health risks can be found in U.S. Nuclear Regulatory Commission Regulatory Guide 8.29, *Instruction Concerning Risks from Occupational Exposure.*
(http://www.nrc.gov/reading-rm/doc-collections/reg-guides/occupational-health/active/8-29/08-029.pdf)

III. IMPORTANT TELEPHONE NUMBERS

Campus Police	**Emergency Ext.**	1-911
Emergency from Cell Phone		(413)538-2304
Environmental Health & Safety		2529

See Committee listing at www.mtholyoke.edu/ehs/safetycommittees for additional contacts.

IV. RESPONSIBILITIES

A. RADIATION SAFETY COMMITTEE

The Radiation Safety Committee is composed of members appointed by Mount Holyoke College. It has jurisdiction over radiation sources and activities at Mount Holyoke College.

The responsibility and authority of the committee include:

1. Ensuring the College's compliance with radiation safety regulations promulgated by Federal, State, and Local Agencies.

2. Establishing policies regarding radiation safety of the Mount Holyoke College Community.

3. Providing direction and advice to the Radiation Safety Officer on matters regarding radiation safety policy.

4. Receiving, reviewing, and acting on all applications for the use of radiation and radioactive material in all areas used by Mount Holyoke College personnel.

5. Issuing usage permits for approved radioactive material activities.

6. Receiving and reviewing periodic reports from the Radiation Safety Officer on monitoring, contamination and personnel exposure.

7. Periodically reviewing the overall use of radiation sources at Mount Holyoke College.

8. Reviewing instances of alleged infraction of use and safety procedures with the Radiation Safety Officer and the responsible individuals.

B. RADIATION SAFETY OFFICER

The Radiation Safety Officer is the operational representative of the Radiation Safety Committee. He/She is responsible for:

1. Implementing policy decisions of the Radiation Safety Committee .

2. Assisting the College in meeting compliance with radiation safety regulations promulgated by Federal, State and Local Agencies.

3. Coordinating the review of all Protocols by the Radiation Safety Committee.

4. Issuing reports of non-compliance to P.I.'s. Recommending sanctions to the committee if a violation persists.

5. General surveillance of all radiation safety activities, including both personnel and environmental monitoring.

6. Furnishing consulting services to personnel at all levels of responsibility on all aspects of radiation safety.

7. Implementing procedures for purchasing, receiving and shipping all radioactive materials coming to or leaving Mount Holyoke College.

8. Surveying all College accelerators, radionuclide laboratories, x-ray machines and other equipment capable of producing ionizing radiations.

9. Distributing and processing of personnel monitoring devices including film badges. The keeping of records of internal and external personnel exposure, and notifying individuals and their supervisors of excessive exposures, as well as recommending appropriate remedial action. Personal exposure information will be made available upon request by an individual.

10. Arranging for the calibration of all portable survey instruments at Mount Holyoke College and maintaining the required records.
11. Instructing users and non-users in proper safety procedures for working with radioactive materials or radiation producing equipment as requested by Licensed Investigators.

12. Supervision and coordination of the waste disposal program, including the processing, storage and disposal of radioactive waste and the keeping of the required records.

13. Performing or supervising the leak tests on all sealed sources and maintaining the required records.

14. Maintaining an inventory of radioactive materials.

15. Responding to laboratory emergencies involving radiation exposure or contamination.

C. ASSISTANT RADIATION SAFETY OFFICER

In the absence of the Radiation Safety Officer, the Assistant Radiation Safety Officer fulfills the duties of the Radiation Safety Officer.

D. LICENSED INVESTIGATOR

Licensed Investigators are responsible for insuring that the individual user responsibilities in subsection E are discharged by those under their supervision and are further responsible for:

1. Adequate planning of experiments and determination of the type and quantity of radiation or radioactive material to be used. This determination will give a good indication of the safety measures that should be employed. Experimental procedures must be well outlined to allow adequate review of safety precautions. Where possible, a cold run using the planned procedures or tracer quantities of radioactive material is recommended to avoid unforeseen safety problems. In any situation where there is an appreciable radioactive hazard, the Radiation Safety Officer should be consulted before proceeding.

2. Establishing procedures to ensure that exposure to all users working under the Investigator's supervision and others present in the laboratory are maintained as low as possible, and specifically below the maximum permissible exposures established in 105 CMR 120 as described in Section V subsections D, E and F.

3. Instructing all users and non-users for whom they are responsible regarding safe techniques and approved radiation safety practices.

4. Ensuring that you are in the laboratory, or on-campus and your whereabouts known, when radioactive materials is being used in your laboratory. Should use be necessary when you are not on campus, you must make arrangements with another authorized investigator to supervise that use. The Radiation Safety Officer should be informed of that arrangement.

5. Amending the protocol in a timely manner with the Radiation Safety Officer whenever changes in operational procedures, new techniques, alterations in physical facilities, or when new operations which might lead to personnel exposure are anticipated.

6. Complying with the regulations governing the use of radioactive materials and radiation producing equipment as established by the Commonwealth of Massachusetts' Department of Public Health, Local regulations, and the Mount Holyoke College Radiation Safety Committee for:

    a. Obtaining approval from the Radiation Safety Committee prior to starting any activities that involve the use of radioactive material.

    b. Using proper procurement and transfer procedures.

    c. Posting areas where radionuclides are kept or used, or where radiation fields may exist.

    d. Security of radionuclides in their possession from unauthorized use.

e. Recording the receipt, transfer and disposal of radioactive materials in their area. This includes sealed sources, such as ion sources in gas chromatographs and static eliminators. Inventory data shall be submitted to the Radiation Safety Officer when requested.

f. Assuring that all radioactive waste materials are disposed in accordance with all applicable regulations and College procedures.

g. Assuring that appropriate records of radionuclide usage are maintained and reported to the Radiation Safety Officer when requested.

h. Providing adequate and appropriate instrumentation for assessing potential radiation hazards in their area and performing routine surveys of the work area as necessary.

i. Taking steps to prevent the transfer of radioactive materials to unauthorized individuals. This includes the proper disposition of radioactive materials possessed by terminating employees and/or students.

7. Keeping the stock of stored radioactive materials to a minimum within laboratory areas.

8. Insuring that service personnel are not permitted to work on equipment, hoods or sinks in radiation areas without first providing specific information.

9. Complying with proper procedures for terminating employment or terminating an experiment using radioactive materials. The Licensed Investigator must return to the Radiation Safety Officer all radioactive materials, including waste, assigned to him under the license. A final termination survey by the Radiation Safety Officer is also necessary.

E. INDIVIDUAL USER

Each individual at Mount Holyoke College who has any contact with radioactive materials or radiation producing equipment, is responsible for:

1. Following all established practices and procedures designed to maintain his/her exposure to radiation as low as possible, and specifically below the maximum permissible exposure as described in Section V, subsection D and E.

2. Wearing the prescribed monitoring equipment such as film badges and finger dosimeters in radiation areas. Personnel who work only with pure alpha emitters, or only with pure beta emitters having a maximum energy of less than 0.2 MeV will not be required to wear film badges.

3. Storing the required monitoring equipment such as film badges and finger dosimeters in the locations prescribed by the Radiation Safety Officer.

4. Surveying their hands, shoes and body for radioactivity and removing all loose contamination before leaving the laboratory.

5. Utilizing all appropriate protective measures such as:

    a. Wearing appropriate clothing whenever working with radionuclides, and not wearing shorts, sandals, etc.
    b. Wearing protective clothing whenever working with radionuclides, and not wearing such clothing outside of the laboratory area.
    c. Wearing gloves and respiratory protection when necessary.
    d. Using protective barriers and other shields whenever possible.
    e. Using mechanical devices when appropriate to reduce exposure.
    f. Using pipette filling devices. Never pipette by mouth.
    g. Performing radioactive work within confines of an approved hood or glove box unless serious consideration has indicated the safety of working in the open.

6. Not eating, drinking, smoking, or applying cosmetics in areas where radioactive materials are present. Refrigerators shall not be used jointly for food, beverages and radioactive materials.

7. Maintaining good personal hygiene. Do not work with radioactive materials if there is an open or unprotected break in the skin below the elbow. Wash hands and arms thoroughly after working with radioactive materials.

8. Checking periodically for contamination in the immediate areas where radioactive materials are being used (hoods, benches, etc.). Any minor contamination observed should be decontaminated. Large amounts of activity found must be decontaminated. The Radiation Safety Officer may be contacted for assistance if necessary.

9. Keeping the laboratory neat and clean. The work area should be free from equipment and materials not required for the immediate procedure. Keep or transport materials in such a manner as to prevent breakage or spillage (double container), and insuring adequate shielding. Keep work surfaces covered with protective material to limit and collect spillage in case of accident.

10. Label and isolate rad)oactive waste and equipment, such as glassware, used in laboratories with radioactive materials. Once used for radioactive substances, equipment should not be used for other work and should not be permitted to leave the area until demonstrated to be free of contamination.

11. Ensuring all contamination is removed from equipment prior to repair by shop personnel or commercial service contractors.

12. Reporting accidental inhalation, ingestion, or injury involving radioactive materials to the Licensed Investigator and the Radiation Safety Officer, and carrying out their

recommended corrective measures. The individual shall cooperate in any and all attempts to evaluate his exposure.

13. Carrying out decontamination procedures when necessary, and taking the necessary steps to prevent the spread of contamination to other areas.

14. Prompt compliance with requests from the Radiation Safety Officer concerning body burden measurements, submission of bioassay samples, and scheduling for requested radiation physical examinations.

V. LICENSE REQUIREMENTS

A. PERSONS APPLYING

As a matter of College policy, the person applying for authorization should be a faculty member of Mount Holyoke College. At the discretion of the Radiation Safety Committee, non-faculty will be considered on a case by case basis. The Radiation Safety Officer will furnish application forms and necessary information.

B. PERMISSIBLE RADIONUCLIDES

Mount Holyoke College's broad scope license authorizes the use and possession of non-exempt quantities of radioactive material. Other radionuclides may be used after the College's Massachusetts license has been appropriately amended and special approval has been given by the Radiation Safety Committee.

C. AUTHORIZATION PROCEDURES

The Radiation Safety Committee desires to have a minimum of "red tape" to secure radionuclides, but not all of it can be eliminated. The Licensed Investigator can save time and trouble by following these instructions and by using as much foresight as possible in anticipating his/her needs.

1. Licensed material shall not be used in or on human beings.

2. To obtain licensed amounts of any radioactive material for non-human use complete the following steps.

    a. Complete a Protocol form (Appendix G) and return to the Radiation Safety Officer.

    b. Contact the Assistant Radiation Safety Officer and make arrangements to view the Radiation Safety training video.

    c. For Licensed Investigators renewing or amending an existing license, only the Protocol form needs to be submitted for review.

3. These completed forms are circulated to the Radiation Safety Committee and when approved the Radiation Safety Officer notifies the applicant.

4. For radionuclides and uses not covered by Mount Holyoke College's license, the Radiation Safety Committee and Massachusetts Department of Public Health must both approve. Application is made on the Mount Holyoke College protocol form.

D. OCCUPATIONAL EXPOSURE

Practices and procedures must be in place to ensure that exposure to radiation is as low as possible, and specifically below the maximum permissible exposure limits established by the Department of Public Health.

1. Occupational Dose Limits for Adults (105 CMR 120.211)

An annual limit of whichever is less of:
1. The total effective dose equivalent (TEDE) being equal to 5 rems (0.05 Sv)
2. The sum of the deep-dose equivalent and the committed dose equivalent to any individual organ or tissue other than the lens of the eye being equal to 50 rems (0.5 Sv)

The annual limit to the lens of the eye, to the skin, and to the extremities, are:
1. An eye dose equivalent of 15 rems (0.15 Sv).
2. A shallow-dose equivalent of 50 rems (0.5 Sv) to the skin or to any extremity.

The assigned deep-dose equivalent and shallow-dose equivalent must be for the part of the body receiving the highest exposure.

2. Occupational Dose Limits for Minors (105 CMR 120.217)

The annual occupational dose limits for minors, persons who have not reached the age of 18, are 10 percent of the annual dose limits specified for adult workers.

E. EXPOSURE OF THE EMBRYO/FETUS

1. Dose Limits to an Embryo/Fetus (105 CMR 120.218)

The dose to an embryo/fetus during the entire pregnancy, due to occupational exposure of adeclared pregnant worker, is limited to 0.5 rem (5 mSv).

Every effort must be made to avoid substantial variation above a uniform monthly exposure rate to a declared pregnant woman so as to satisfy the limit above.

The dose to an embryo/fetus shall be taken as the sum of:
1. The deep-dose equivalent to the declared pregnant woman.

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

If by the time the woman declares pregnancy to Mount Holyoke College, the dose to the embryo/fetus has exceeded 0.45 rem (45 mSv), the College shall be deemed to be in compliance with 150 CMR 120.218(A), if the additional dose to embryo/fetus does not exceed 0.05 rem (0.5 mSv) during the remainder of the pregnancy. Section V.O. describes procedures for declaring a pregnancy.

A declared pregnant woman may not use radioactive material or radiation producing equipment in such a manner that the embryo/fetus could receive a dose in excess of the limits specified in 105 CMR 120.218.

F. EXPOSURE TO THE PUBLIC

1. Dose Limits for Individual Members of the Public (105 CMR 120.221)

The College shall ensure that:

a) The total effective dose equivalent (TEDE) to individual members of the public from licensed operations does not exceed 0.1 rem (1 mSv) in a year, exclusive of the dose contribution from the disposal of radioactive material into sanitary sewage in accordance with 105 CMR 120.253.

b) The dose in any unrestricted area from external sources does not exceed 0.002 rem (0.02 mSv) in any hour.

c) The total effective dose equivalent (TEDE) to individual members of the public from infrequent exposure to radiation from radiation machines does not exceed 0.5 rem (5mSv).

G. LABORATORY CLASSIFICATIONS

1. Unsealed Sources

Information for Classifying Laboratories

Radionuclide Group	Survey Frequency Category Low	Medium	High
1	< 10μCi	10μCi to 1mCi	> 1mCi
2	< 1mCi	1mCi to 100mCi	> 100mCi
3	< 100mCi	100mCi to 10Ci	> 10Ci
4	< 10Ci	10Ci to 1000Ci	> 1000Ci

Proportional fractions are to be used for more than one radionuclide.

Modifying Factors	Factors
Simple storage	x 100
Very simple wet operations (e.g., preparation of aliquots of stock solutions)	x 10
Normal chemical operations (e.g., analysis, simple chemical preparations	x 1
Complex wet operations (e.g., multiple operations, or operations with complex glass apparatus)	x 0.1
Simple dry operations (e.g., manipulation of powders) and work with volatile radioactive compounds	x 0.1
Exposure of non-occupational persons	x 0.1
Dry and dusty operations (e.g., grinding)	x 0.01

The object is to determine how often to survey the laboratory. To do this, multiply the activity range under Low, Medium, and High survey frequency by the appropriate Modifying Factor to construct a new set of mCi ranges for Low, Medium, and High survey frequency.

EXAMPLE: A lab in which 10mCi of Group II radionuclide is used in normal chemical operations should be surveyed on a Medium frequency. However, if only simple storage is done, then a Low frequency is adequate (< 1mCi x 100 = < 100mCi new Low range). But if a dry grinding operation is done, a High frequency is required (> 100mCi x 0.01 = > 1mCi new High range). See Appendix VII(a)-J for ICRP Radionuclide Groups.

2. Sealed Sources

The Radiation Safety Committee assigns laboratory classifications for sealed sources on a case by case basis. Radioactive material, construction of source container, and proposed uses are examples of items considered in assigning the laboratory classification.

H. COMPLIANCE WITH REGULATIONS

Each Licensed Investigator is responsible for ensuring that all laboratories and personnel under his/her control comply with the applicable Federal, State, and Local regulations; and College policies and procedures. The College's Radiation Safety Officer will provide consultation advice regarding the various regulations, however, the Licensed Investigator is ultimately responsible for all activities. All users and non-users working in a radionuclide laboratory should become familiar with the following:

1. Commonwealth of Massachusetts, Department of Public Health -- Chapter 105 CMR 120.

2. Mount Holyoke College -- Radiation Safety Policy and Procedure Manual.

All the above regulations are maintained in the Environmental Health and Safety Office and are available for review.

Licensed Investigators should also be aware that in addition to items 1 and 2 above, Mount Holyoke College must comply with the following regulations:

1. U.S. Environmental Protection Agency -- Title 40, Code of Federal Regulations.

2. U.S. Department of Transportation -- Title 49, Code of Federal Regulations.

3. U.S. Department of Labor, OSHA -- Title 29, Code of Federal Regulations.

I. SURVEYS AND AUDITS

Each laboratory using radioactive materials must provide the appropriate radiation detection instruments to enable it to conduct routine surveys for radiation exposure and/or surface contamination. The frequency of these surveys will generally be set by the laboratory classification as follows.

Low . . . . . not less than monthly
Medium . . . . . not less than weekly
High . . . . . not less than once per normal working day

The above frequency of routine surveys shall not be considered as fixed. When any survey reveals contamination above the limits specified by the College's policies and procedures, the Radiation Safety Officer shall be notified and the laboratory may be placed into the next higher frequency until it is in compliance with the acceptable limits. Likewise, laboratories consistently displaying excellent radiation safety practices may be placed in a less frequent schedule by the Radiation Safety Officer. The RSO will also perform routine lab surveys on a regular basis. If there are conditions found in non-compliance, a **Radiological Occurrence Report** will be issued to the licensed investigator (see Appendix A).

The minimum survey frequency for all laboratories using unsealed radioactive sources is quarterly.

The minimum survey frequency for all laboratories using sealed radioactive sources is semi-annually with the exception of sealed sources declared in storage.

Radiation Safety Officer audits include a review of radiation surveys, records, and procedures specified as conditions of approval in the usage permit issued to each Licensed Investigator. Audits are scheduled annually. This does not preclude the Radiation Safety Officer from increasing audit frequency as necessary to assure and document Mount Holyoke College's compliance.

J. CONTAMINATION LIMITS

1. An individual wipe test should routinely cover approximately 100 - 150 cm^2. Ideally, any contamination more that a few DPM above background should be cleaned up; however, a more usual level for beta/gamma at which cleanup is initiated is about 200 DPM. At approximately 1000 DPM a contamination zone should be established until the contamination is removed.

2. Contamination levels may also be estimated with a survey meter. As a rough rule of thumb, establish a contamination zone if readings are > 100 CPM for Groups 1 and 2 radionuclides and > 1000 CPM for Groups 3 and 4 radionuclides when measured with a thin window GM meter. Of course, this particular instrument will not detect low energy beta emitters such as tritium.

3. Notify the Radiation Safety Officer if contamination is suspected beyond the designated radioactive material laboratory boundaries.

4. In all cases notify the Radiation Safety Officer if clean-up is not successful.

5. You may notify the Radiation Safety Officer at lower levels if you wish assistance in clean-up or if you wish your clean-up results checked.

6. Clean-up suggestions:

   a. Be sure to wear protective clothing while cleaning (gloves, lab coats, shoe covers, etc.).

   b. Use mild soap or other appropriate cleanser for the material which has been spilled.

   c. Work from the outside of the spill toward the center being careful not to spread the contamination and reduce the "counts" by dilution.

   d. Rewipe after cleaning to check your technique.

K. STORAGE POLICY

1. The storage of radioactive material in the laboratories shall comply with the following:

   a. Radioactive material shall be kept or stored in a manner that will provide minimum exposure to personnel.

   b. Suitable storage precautions shall be taken against fire, explosion, flooding, or unauthorized removal.

L. CALIBRATION OF SURVEY METERS

Radiation survey meters shall be calibrated annually. This calibration will be done by an approved calibration facility or by the Radiation Safety Officer using NRC approved procedures.

M. LICENSED INVESTIGATOR ABSENT OR ON LEAVE

During an absence from Mount Holyoke College of more than two weeks, a Licensed Investigator shall make arrangements to have another Licensed Investigator be responsible for his/her licensed material if research activities are continued.

The Licensed Investigator should also inform the department head and laboratory staff of the arrangements. The faculty person designated is expected to assume the responsibilities of the licensee to oversee radioactive material use.

N. VISITORS AND PETS IN THE RADIONUCLIDE LABORATORIES

Licensed Investigators shall restrict casual traffic through laboratory areas where radioactive materials are used. Common sense and good judgement should be exercised to avoid accidents, especially where the exposure of minors is possible.

Pets are not allowed in laboratories where radioactive materials are used or stored.

O. PRENATAL RADIATION EXPOSURE

The developing embryo/fetus is considered more sensitive to radiation than an adult. The main concern is embryo/fetus susceptibility to the harmful effects of radiation such as cancer. A woman working with radiation who becomes pregnant has the option of formally declaring her pregnancy to take advantage of lower established dose limits for the embryo/fetus. Commonwealth of Massachusetts regulations require that if a woman formally declares her pregnancy in writing, the embryo/fetus dose from occupational exposure of the mother not exceed 0.5 rem (5 mSv) over the entire pregnancy. (See section V.E. for additional details.) If a woman chooses not to formally declare her pregnancy, the woman and her embryo/fetus continue to be subject to the occupational dose limits that apply to all other radiation workers. Female workers must understand that by not declaring their pregnancy, they assume full responsibility for their decision.

A female worker wishing to formally declare her pregnancy, must provide the following information in writing to the chair of the Radiation Safety Committee with a copy to the Radiation Safety Officer:

1. Date of declaration
2. Full name
3. Social Security Number – This is to ensure that the doses are properly logged in the exposure history records.
4. A statement declaring she is pregnant.

5. An estimated date of conception – The due date minus 9 months is acceptable. This information is required for dose estimate purposes
6. Signature

Upon receiving a pregnancy declaration, the Radiation Safety Officer will calculate the dose to the embryo/fetus between conception and the date of declaration. The Radiation Safety Officer, after consultation with the Radiation Safety Committee, will meet with the woman, and her supervisor if applicable, to discuss the risk associated with the radioactive material(s) used, dose received to date, work procedure requirements and restrictions, and monitoring requirements. The Radiation Safety Officer will stay in contact with the woman during her pregnancy with updated information on dose received, and may impose additional restrictions including work with radiation sources.

It is recommended that decision should be made regarding declaring the pregnancy or other actions early in the pregnancy as the embryo/fetus is considered the most sensitive in the first trimester. Prudent practices for limiting prenatal exposure could include:

1. Reducing exposure by decreasing the amount of time spent in the radiation area, increasing the distance from the radiation source, and using shielding. Extreme care should be exercised when performing experiments or procedures where you might become contaminated. It is also very important to reduce the potential of an ingestion of radioactive materials during pregnancy. Certain radionuclides may cross the placental barrier and concentrate in the fetus.

2. Requesting reassignment to areas involving less exposure to radiation. If this is not possible, consider discussing a transfer within Mount Holyoke College with the Human Resources Department, or leaving your job.

Additional information can be found in the following documents available online and from the Radiation Safety Officer.

U.S. Nuclear Regulatory Commission Regulatory Guide 8.13, *Instruction Concerning Prenatal Exposure.*
(http://www.nrc.gov/reading-rm/doc-collections/reg-guides/occupational-health/active/8-13/08-013.pdf)

U.S. Nuclear Regulatory Commission Regulatory Guide 8.29, *Instruction Concerning Risks from Occupational Exposure.*
(http://www.nrc.gov/reading-rm/doc-collections/reg-guides/occupational-health/active/8-29/08-029.pdf)

VI. PERSONNEL MONITORING AND TRAINING

A. TRAINING

105 CMR 120.753 requires that each individual likely to receive an occupational dose be given information on the radiation hazards to be experienced, biological effects of radiation, and techniques of radiation protection. The Licensed Investigator is responsible for training the

individuals working in his/her laboratory. Refresher training for individuals who will use or be present near licensed radioactive material will be conducted annually. The materials in Appendices D, E and F should be reviewed as part of the training. The training record in Appendix I must be completed and a copy sent to the Office of Environmental Health and Safety.

B. PERSONNEL DOSIMETRY

It is the intent of the Radiation Safety Committee to maintain occupational radiation exposures at a minimum. In order to accomplish this, the following methods of personnel monitoring are employed:

1. Film Badges

Except for individuals using soft beta emitters (max. Energy < 0.2 MeV) and pure alpha emitters, everyone directly involved with radioactive materials, or ionizing radiation producing equipment at Mount Holyoke College facilities may be required to have and wear a film badge when working. Requests for film badges should be made to the Radiation Safety Officer. The film badge request shall have the following information:

Name of Applicant (Printed or Typed)
Date of Birth
MHC ID# (from All-Campus ID card)
Licensed Investigator's Name

Users who are not Mount Holyoke faculty, staff or students must obtain a Mount Holyoke Visitor identification card from Auxilary Services.

Ring badges may be required when handling radioactive material in situations where the hand exposures may be significant. Ring badges may also be requested from the Radiation Safety Officer when needed.

2. Bioassays

Bioassays will be required of all researchers using ^{3}H and/or ^{125}I according to the following:

a. Occasional use of 10mCi or more of ^{3}H labeled compounds or 100mCi or more of other un-contained forms of ^{3}H labeled material will require a bioassay within 48 hours after completion of the work. Continuous use requires weekly bioassays.

b. Occasional use of carrier-free ^{125}I for iodinations requires thyroid counting at 48 hours after completion of the work. Continuous use requires weekly bioassays.

c. Bioassays for uptakes of other radionuclides will be done as determined by the Radiation Safety Committee prior to research authorization.

The tritium bioassay procedure will consist of:

a. Twenty-four hour composite urine samples will be collected by the individual involved as requested by the Radiation Safety Committee or Radiation Safety Officer.

b. Calibrate the Liquid Scintillation Counter.

c. 1ml of tap water in 10ml fluor will be used for the background count.

d. 1ml of urine in 10ml fluor is counted for 10 minutes in the Liquid Scintillation Counter. Record counts.

e. Add 10µl of $2x10^4$dpm/10µl calibration solution to a second vial containing 1ml of urine in 10ml fluor and count 10 minutes in the Liquid Scintillation Counter. This permits accurate computation of counting efficiency even in the presence of quenching.

For ^{125}I thyroid counting, researchers will be counted at Mount Holyoke College at the appropriate time following the experiment. Two minute thyroid counts will be performed using an external scintillation probe with a single channel analyzer or multichannel analyzer system.

3. Radiation Physicals

Emergency medical examinations for anyone suspected of being overexposed to radiation may be arranged by contacting the Radiation Safety Committee or Radiation Safety Officer. Emergency medical examinations will be designed to satisfy the requirements of the particular emergency.

C. PERSONNEL EXPOSURE INVESTIGATION LEVELS

The College has established the following investigational levels as recommended by the NRC:

	Level I	**Level II**
Deep Dose Equivalent	125 mrem/qtr	375 mrem/qtr. or 125 mrem/mo.
Eye Dose Equivalent	375 mrem/qtr. or 125 mrem/mo.	1125 mrem/qtr. or 375 mrem/mo.
Shallow Dose Equivalent to Skin or Extremities	1250 mrem/qtr. or 417 mrem/mo.	3750 mrem/qtr. or 1250 mrem/mo.

The Radiation Safety Officer will review all dosimetry reports from commercial vendors on a monthly basis. The following actions will be taken in those cases where exposure levels at least meet or exceed the investigational levels listed above:

a) Except when deemed appropriate by the Radiation Safety Officer, no further action will be taken in those cases where an individual's exposure is less than Level I.

b) The Radiation Safety Officer will review the exposure of each individual whose monthly exposures equal or exceed Level I. The Radiation Safety Officer will consider each such exposure in comparison with those of others performing similar tasks as an index of ALARA program quality. The Radiation Safety Officer will report the results of his reviews to the Radiation Safety Committee by e-mail or other correspondence. If the exposure does not equal or exceed Investigational Level II, no action specifically related to the exposure is required unless deemed appropriate by the Radiation Safety Committee. The review will be discussed at the next Committee meeting and recorded in the Committee Minutes.

c) The Radiation Safety Officer will investigate in a timely manner the cause(s) of all personnel exposures equaling or exceeding Investigational Level II and, if warranted, take action. A report of the investigation, actions taken, if any, and a copy of the individual's incident report form will be presented to the Director of Environmental Health and Safety upon completion of the investigation. The details of these reports will be recorded in the meeting with the Director of Environmental Health and Safety and other appropriate College officials. The Director of Environmental Health and Safety and the Radiation Safety Officer will, at that time, decide on the appropriate corrective action.

d) In a case where a worker's or a group of workers' exposures need to exceed Investigational Level I, a new higher Investigation Level II may be established on the basis that is consistent with good ALARA practices for that individual or group. Justification for a new investigational Level II will be documented.

The Radiation Safety Committee will review the justification for, and will approve all revisions of Investigational Level II. In such cases, when the exposure equals or exceeds the newly established Investigational Level II, those actions listed in paragraph C above will be followed. The details of the investigation, will be made available to NRC and State inspectors for review at the time of the next inspection.

VII. PROCUREMENT AND USE OF RADIONUCLIDES

A. PROCEDURES FOR PROCUREMENT

Orders for radioactive materials must be documented on a *Radiation Purchase and Receipt Report* (Appendix H). Only authorized Investigators, or designated staff, can order radionuclides. The Environmental Health & Safety Office provides the Stockroom Manager with a list of faculty and staff members authorized to order radioisotopes. Investigators wishing to designate staff as authorized to order and receive radionuclides, must include ordering and receipt procedures in

training for those staff and notify the Environmental Health & Safety Office that the person is authorized by the investigator to order and receive radionuclides.

Ordering information must be sent to the Radiation Safety Officer and Science Stockroom Manager the same day the material is ordered. When placing the order, the Investigator should specifically request delivery on a specific day, on which the investigator will be available to accept the package, during normal working hours, Monday - Friday. No orders can be accepted on Saturday, Sunday or College holidays.

The Radiation Safety Officer reviews all order information to insure that the requested materials and quantities are authorized by the license and that possession limits are not exceeded. The Radiation Safety Officer maintains current radioactive material possession information.

B. RECEIPT OF RADIONUCLIDES

All orders are received at the Science Center Stockroom. Upon receipt of the order, the Stockroom will contact the Investigator who will pick-up the package, or designate an authorized user to pick-up the package, at the Stockroom and return to their radiation lab to monitor the package. If the Investigator is not available to pick-up the package, the stockroom will call an Investigator identified as a back-up to collect the package from the stockroom. If the package can not be immediately picked up it will be held in a secure stockroom location.

The Investigator or an authorized user will monitor the package before opening and monitor the packing material for contamination after opening in their lab using the procedure in Appendix D. The *Radiation Purchase and Receipt Report* (Appendix H) is then completed and the form sent to the Radiation Safety Officer.

C. TRANSFER OF RADIONUCLIDES TO OTHER INDIVIDUALS

The transfer of radionuclides between individuals and/or laboratories is to be discouraged as a practice; however, where a real need exists it may be done.

No radioactive material may be transferred or used outside Mount Holyoke College, except with permission from the Radiation Safety Committee.

D. TRANSPORTATION OF RADIOACTIVE MATERIAL

1. To comply with Federal, State, and Local regulations, radioactive material to be transported outside of Mount Holyoke College property boundaries must be packaged in accordance with U.S. Department of Transportation regulations. The Radiation Safety Officer can assist in preparing packages for shipment to ensure compliance with the regulations.

2. Transportation of radioactive material within the College's property boundaries must conform to the following:

a. During transit, the material shall be in the possession and responsible charge of an authorized user of the material.

b. The transportation route and time should be planned so that there will be minimal foot-traffic encountered and also minimal radiation exposure to locations where low-level radiation measurements are being conducted.

c. The material shall be transported in a closed, shatterproof container that is properly labeled.

d. The measured dose rates shall not exceed:
   i. 200 mrem/hour (2 mSv/hour) at any point on the external surface of the container.
   ii. 10 mrem/hour (0.1 mSv/hour) at one meter from any external surface of the package.

e. The transferable surface contamination as measured by a wipe test shall not exceed 1000 dpm/100cm² of alpha or beta-gamma activity.

E. GENERAL REQUIREMENTS AND PRECAUTIONS

1. The minimum standards for handling radionuclides must meet Commonwealth of Massachusetts' Department of Public Health regulations 105 CMR 120. In addition, the recommendations of the National Council on Radiation Safety and Measurements (NCRP) are considered to be the basis of good practice and are valuable guides, especially **NCRP Report 8, "Control and Removal of Radioactive contamination in Laboratories" and NCRP Report 30, "Safe Handling of Radioactive Materials".**

2. In addition to the Licensed Investigators' and users' responsibilities, a set of standard practices and procedures for laboratory work with radionuclides is given in Appendix C.

F. LEAK TEST REQUIREMENTS FOR SEALED SOURCES

1. Sealed sources and detector cells shall be tested for leakage and/or contamination at intervals not to exceed 6 months or at such other intervals as specified by the certificate of registration referred to in 105 CMR 120, not to exceed 3 years.

2. Sealed sources designed to emit alpha particles shall be tested for leakage and/or contamination at intervals not to exceed 3 months.

3. In the absence of a certificate from a transferor indicating that a test has been made within six months prior to the transfer, a sealed source or detector cell received from another person shall not be put into use until tested.

4. Each sealed source fabricated by the College shall be inspected and tested for construction defects, leakage, and contamination prior to any use or transfer as a sealed source.

5. Sealed sources and detector cells need not be leak tested if:
   a. They contain only hydrogen-3.
   b. They contain only a gas.
   c. The half-life of the nuclide is 30 days or less.
   d. They contain not more than 100 microcuries of beta and/or gamma emitting material or no more than 10 microcuries of alpha emitting material.
   e. They are not designed to emit alpha particles, are in storage, and are not being used. However, when they are removed from storage for use or transfer to another person, and have not been tested within the required leak test interval, they shall be tested before use or transfer. No sealed source or detector cell shall be stored for a period of more than 10 years without being tested for leakage and/or contamination.

6. The test shall be capable of detecting the presence of 0.005 microcuries of radioactive material on the test sample. If the test reveals the presence of 0.005 microcuries or more of removable contamination, the Radiation Safety Officer shall be notified and the source shall be removed from service.

7. Records of leak tests results shall be kept in appropriate units.

8. It is the responsibility of the Licensed Investigator to ensure that such leak tests are performed.

G. RADIOACTIVE MATERIAL CONTAINED IN EQUIPMENT

All equipment which contains radioactive materials is regulated as follows:

1. Equipment that is regulated by general license issued under 105 CMR 120.121 and 105 CMR 120.122 should be registered with the Radiation Safety Officer. (Gas Chromatographs, Liquid Scintillation Counters, etc.)

2. Equipment that requires specific licensing, as with other radionuclides, must be approved by the Radiation Safety Committee.

3. This equipment should be labeled with a "Caution Radioactive Material" sign or other label.

H. CONTROL OF EXPOSURE TO RADIATION

The following guidelines govern the use of ionizing radiation in educational institutions and shall be distributed to students participating in demonstrations and/or experiments involving radiation at Mount Holyoke College:

1. Individuals in the general population of any age should not receive an exposure exceeding 0.1 rem (1 mSv) total effective dose equivalent (TEDE) per year in addition to natural

background and medical exposures. This limit applies to those persons who are not occupationally exposed. If an instructor or student of age 18 or greater is subjected routinely to work involving radiation, then he/she is an occupational worker and must be authorized to perform such work.

2. Individuals using radioactive compounds in gas chromatography equipment must vent the cell-exhaust through tubing into an approved hood or trap. This procedure will avoid contamination of work areas from the release of radioactive tagged samples introduced into the system or from the accidental overheating of radioactive foils in the cells.

3. Students should not receive whole body exposures exceeding 0.1 rem (1 mSv) total effective dose equivalent (TEDE) per year due to their educational activities. It is recommended that each experiment be planned so that no individual receives more than 0.01 rem (0.1 mSv) while conducting or participating in the experiment.

It should be emphasized that there is no difficulty in performing radiation experiments and demonstrations in conformity with the above recommendations if appropriate safeguards are provided.

VIII. RADIOACTIVE WASTE DISPOSAL

The Commonwealth of Massachusetts requires that all licensees maintain written records regarding disposal of radioactive waste material. In order for the College to meet the legal requirements, Licensed Investigators are required to maintain appropriate records on the waste drums. The Radiation Safety Officer will compile the appropriate records from the information supplied by the Licensed Investigators for State inspections. Each Licensed Investigator is responsible for the secure and safe storage of radioactive waste generated until it is picked up by the Radiation Safety Officer. This generally means temporary storage within the individual's laboratory. In addition, appropriate shielding and containment of vapors shall be considered by the Licensed Investigator.

If radioactive waste is removed from a laboratory by unauthorized individuals (namely, housekeeping personnel) contact the Radiation Safety Officer immediately. The following information should be helpful in fulfilling this responsibility and outlines Mount Holyoke College's current procedures.

A. SOLID DRY WASTE

Solid disposable lab wear and materials are all segregated by radionuclide and either held for decay or placed in a 55 gallon drum for final disposal via shipment to an approved burial site by a licensed broker. Materials held for decay are those with half-lives less than or equal to 90 days. Materials with half-lives of greater than 90 days are shipped out after a suitable number of drums are collected.

Special waste receptacles are provided by the Radiation Safety Officer to the various departments utilizing radioactive materials for the disposal of solid dry waste. These receptacles are identified with the magenta and yellow radiation symbol and the words, "Caution - Radioactive Material".

B. LIQUID WASTE

1. Non-hazardous liquid radioactive waste or used non-hazardous liquid scintillation fluids are disposed into the sanitary sewer via the laboratory sinks in radioactive material laboratories.

2. Liquid Scintillation vials that contain less than or equal to 0.05μCi/gm of ^{3}H or ^{14}C are disposed of via a licensed broker if they are of a hazardous chemical base. If non-hazardous LSC formulas are used and the vials contain less that or equal to 0.05μCi/gm of ^{3}H or ^{14}C, these are disposed in the normal trash. LSC vials containing other radionuclides with half-lives of less than or equal to 90 days are segregated and held for decay, 10 half-lives, and then disposed as hazardous chemical waste or in the normal trash if non-hazardous formulas are used.

C. ANIMAL CARCASSES AND ASSOCIATED WASTE

Animal carcasses containing radioactive material with half-lives of less than or equal to 90 days are stored frozen until 7 - 10 half-lives have passed and then disposed as non-radioactive waste.

RADIOLOGICAL OCCURRENCE REPORT

☐ **OBSERVATION** ☐ **DEFICIENCY** ☐ **VIOLATION**	REPORT NO.
TO (PRINCIPAL INVESTIGATOR):	DATE: / /
OCCURRENCE OBSERVED BY:	LOCATION:

PART I:

Description of Radiological Occurrence:

Immediate Corrective Actions Taken:

Signature:_____ Date____/____/____.
RSO / Consultant

Long Term Corrective Actions (if required):

PART II:

P.I. RESPONSE: (Please complete this section if VIOLATION is checked above and return to the RSO within 3 working days of notification. Repeated occurrences may warrant issuance of a Radiological Violation. No response necessary for an OBSERVATION OR DEFICIENCY checked above.)

Signature:_____ Date: ____/____/____.
Principle Investigator

PART III:

RUC Disposition:

Signature:_____ Date: ____/____/____.
RUC Chairperson

CONTROL OF STUDENT EXPOSURE TO RADIATION

Mount Holyoke College recommends the following guides on the uses of ionizing radiation. They should be distributed to students participating in demonstrations or experiments involving radiation:

1. Persons in the general population at any age. — Such individuals should not receive an exposure exceeding 0.1 rem per year (1 mSv/yr) total effective dose equivalent in addition to natural background and medical exposure. This limit applies to those persons who are not occupationally exposed. An instructor or student of age 18 or greater subjected routinely to work involving radiation is an occupationally exposed worker. Their exposure limit is 5 rems per year (0.05 Sv/yr) total effective dose equivalent and 50 rems per year (0.5 Sv) committed dose equivalent to any tissue or organ.

2. Persons under 18 years of age may not use radioactive material or radiation producing equipment in such a manner that they may receive a dose in excess of the limits specified in 105 CMR 120.217.

3. Students under 18 years of age exposed during educational activities. — Such individuals should not receive whole body exposure exceeding 0.1 rem per year (1 mSv/yr) total effective dose equivalent due to their educational activity. To provide an additional factor of safety, Mount Holyoke College recommends that each experiment be planned so that no individual receives more than 0.01 rem (0.1 mSv) while conducting or participating in the experiment.

4. Students over 18 years of age exposed during educational activities fall into category 1.

It should be emphasized that there is no difficulty in performing radiation experiments and demonstrations in conformity with the above recommendations, if appropriate safeguards are provided.

Mount Holyoke College recommends the following precautions when students handle radionuclides:

1. “Good housekeeping” should be maintained always. Keep the laboratory neat, wash glassware regularly and do not let waste or contaminated material accumulate.

2. Perform a “mock” run, when practical, using stable or low-activity material to establish the adequacy of procedures and equipment for handling the radioactive material.

3. Measure and evaluate the radiation levels at the hand and body locations before carrying out intended operations on a source of radioactive material.

4. Use a fume hood or glove box when performing operations that might produce airborne contamination, (evaporations, sanding or grinding operations, transfers of unsealed powdered material, etc.)

5. Wear protective gloves and a lab coat, and closed shoes (heel and toe) with no perforations when performing operations to prevent skin or clothing contamination.

6. Survey skin, hair and clothing after handling unsealed radioactive material, and wash hands before leaving the laboratory.

7. Do not eat, drink, smoke, or apply cosmetics in laboratories where unsealed radioactive material is handled, unless in a specifically marked area. Do not store food in a laboratory's radionuclide storage refrigerator.

8. Do not pipette radioactive solutions by mouth.

9. Do not handle radioactive sources by hand unless you are certain that the contact dose is within permissible limits and that the source is not contaminated externally.

10. All containers of radioactive material should be properly labeled at all times. The label should indicate the date of assay and the kind and quantity of radioactive material, and should carry the standard yellow and magenta radioactivity symbol.

11. Containers of radioactive solutions shall be kept closed unless in actual use.

12. Radioactive sources shall be stored when not in use, in a suitably labeled location with means to prevent unauthorized use when not in use. Adequate shielding should be provided.

13. Contact the Licensed Investigator if a spillage or accident involving RAM or radiation occurs.

GENERAL RADIATION PROTECTION REQUIREMENTS AND PRECAUTIONS

1. There shall be no smoking, eating, drinking, applying cosmetics, or storage of food in any area where unsealed and unpacked sources of radioactive materials are used, handled, transferred, or stored.

2. Dogs or other pets are not allowed in radioisotope laboratories or area.

3. There shall be no mouth pipetting of radioactive solutions.

4. Whenever practical, the user should perform a trial experimental run using inactive (or low activity) material to establish the adequacy of procedures and equipment.

5. Before performing operations on a source of radioactive material, radiation levels shall be measured. Handling tongs, or a suitable remote-handling device shall be used for handling a source or container that emits a dose rate, at contact, in excess of 0.1 rem per minute (1 mSv/min), unless specifically authorized by the Radiation Safety Committee.

6. When performing operations that might produce airborne contamination (i.e., evaporations, sanding, or grinding, transfers of unsealed powdered or volatile radioactive material), exhaust ventilation approved by the Radiation Safety Committee shall be used.

7. Protective gloves, a lab coat, and closed shoes (heel and toe) with no perforations shall be worn at all times during operations involving the handling of unsealed radioactive materials.

8. After handling unsealed radioactive material, wash hands before leaving the laboratory.

9. Materials and equipment shall be surveyed before removal from a potentially contaminated area.

SECURITY

Non-exempt quantities of radioactive material in a laboratory shall be under the constant surveillance and immediate control of an authorized user or secured from unauthorized removal from the laboratory.

CAUTION SIGNS AND LABELS

1. Each laboratory storing or using radioactive material must be posted with appropriate signs, in conformity with 105 CMR 120.

2. Each container of radioactive material shall be labelled by the user in conformity with the following procedures, which meet State regulations:

    a) Each container holding radioactive material more that the quantities listed in 105 CMR 120.242 must have a durable, clearly visible label bearing the radiation caution symbol and

the words "CAUTION RADIOACTIVE MATERIAL" or “DANGER RADIOACTIVE MATERIAL”.

b) These labels should state the quantities and kinds of radioactive materials in the containers, and date of measurements of quantities.

c) Labeling is not required for laboratory containers, such as beakers, flasks, and test tubes used transiently in the laboratory procedures while the user is present.

d) For purposes of these labeling requirements, when there is a combination of radionuclides in known amounts, the limit of the combination will be derived as follows: Determine for each radionuclide in the combination the ratio between the quantity present and that quantity listed for the radionuclide in 105 CMR 120.242. The sum of ratios for all radionuclides in the combination may not exceed 1.

WORK SURFACES

All work areas (bench tops, hoods, floors, etc.) as well as storage areas adjacent to permanent setups and sinks should be covered at all times with stainless steel, plastic trays, or other impervious materials. For some purposes plastic backed absorbent paper will be satisfactory. If such paper is used, it should be discarded frequently to prevent the spread of contamination.

PERIODIC SURVEYS OF RADIATION AREAS

The immediate areas (hoods, bench tops and storage areas) where radioactive materials are used should be checked for contamination periodically by the radiation workers in that laboratory. In addition, these areas should be inspected every time there is reason to suspect a contamination incident.

RADIOACTIVE CONTAMINATION OF AREAS

No radioactive contamination can be tolerated. Exceptions are active work areas clearly marked with the standard radiation caution signs or tape. Any contamination not confined to protected surfaces should be reported immediately to the Licensed Investigator. The Licensed Investigator will supervise the decontamination of these areas or equipment.

DECONTAMINATION OF AREAS CONTAMINATED WITH RADIOACTIVITY

Preparations for decontamination should begin promptly after you have determine the extent of the contamination. The individual responsible for the contamination will generally do the clean-up under the supervision of the Licensed Investigator. The area or equipment should be considered contaminated until proven otherwise.

Equipment purchased with grant funds will not be released by the College until laboratories under a departing investigator have been inspected and release by the Radiation Safety Officer in writing. It is the responsibility of the departing investigator to accomplish any necessary decontamination.

DECONTAMINATION OF PERSONNEL CONTAMINATED WITH RADIOACTIVITY

Notify Licensed Investigator immediately after a contamination accident. Wash body area involved thoroughly for 2 or 3 minutes using only mild soap and lukewarm water. If this procedure is not immediately and completely effective, notify the Radiation Safety Officer.

AEROSOLS, DUSTS AND GASEOUS PRODUCTS

Procedures involving aerosols, dusts or gaseous products, or procedures that might produce airborne contamination shall be conducted in a hood, glove box or other suitable closed system. All releases from such systems shall not exceed the maximum permissibly concentration in air for the radionuclide in question. See 105 CMR 120.296 for appropriate values. Where practical traps should be incorporated in the experimental setup to insure that environmental releases are as low as possible. Radioactive gases or materials with radioactive gaseous daughters must be stored in gas-tight containers and kept in areas having approved ventilation. Hoods used for radionuclide work must be tested to insure that they meet the minimum requirements for air velocity at the face of the hood.

IODINE VAPORS

Procedures that could generate iodine vapors shall be conducted in a glove box or radionuclide hood with an adequate flow rate and charcoal filters. Advice must be sought from the Radiation Safety Officer before conducting experiments with iodine and the facilities should be evaluated for containment purposes.

PROCEDURES FOR SAFELY OPENING PACKAGES CONTAINING RADIOACTIVE MATERIALS

For all packages, the following procedures should be carried out within 3 hours of receipt of the package:

a) Put on gloves to prevent hand contamination.

b) Visually inspect package for any sign of damage (e.g. wetness, crushed). If damage is noted, stop procedure and notify Licensed Investigator.

c) Measure exposure rate at 3 feet (or 1 m) from package surface and record. If greater than 10 mR/hr stop procedure and notify the Licensed Investigator.

d) Open the package with the following precautionary steps:
   1. Open the outer package (following manufacturer's directions, if supplied) and remove packing slip.
   2. Open inner package and verify the contents agree with those on the packing slip. Compare requisition, packing slip, and label on bottle.
   3. Check integrity of final source container (i.e. inspect for breakage of seals or vials, loss of liquid, and discoloration of packaging material.
   4. Check also that shipment does not exceed possession limits.

e) Wipe external surface of final source container and remove wipe to low background area. Assay the wipe and record amount of removable radioactivity (e.g. $\mu Ci/100cm^2$).

f) Monitor the packing material and packages for contamination before discarding.
   1. If contaminated, treat as radioactive waste.
   2. If not contaminated, obliterate radiation labels before discarding in regular trash.
   3. Maintain records of the results of checking each package, using "Radioisotope Status Report".

MOUNT HOLYOKE COLLEGE EMERGENCY PROCEDURES

MINOR SPILLS

(Generally defined as amounts of activity routinely used in bench top experiments that can vary from a few micro-Curies to as high as 200 micro-Curies but in very small volumes of research material.)

1. If spill is liquid and the hands and clothing are protected to minimize spillage.

2. If spill is on the skin, flush thoroughly with water.

3. If spill is on clothing, discard outer or protective clothing at once.

4. Absorbent paper, appropriate metal trays, or glass trays on all bench surfaces. This should be sufficient to contain most lab bench spills (typically life science volumes containing radioactive materials are 10ml or less). A floor spill of this nature will be contained with paper towels and/or absorbant clay which may be available in labs utilizing radioactive materials.

5. Final decontamination of contaminated surfaces will be accomplished with foaming cleaner containing 3% sodium EDTA.

6. Notify the Licensed Investigator and the Radiation Safety Officer about the incident.

MAJOR SPILLS

(Major spills are typically greater than 200 micro-Curies in large volumes of research material that would be difficult to re-contain without assistance.)

1. Same procedures as for Minor Spills up to item 4.

2. If external radiation levels are high, evacuate exposed personnel from accident scene and assure that they remain confined until monitored.

3. Notify the Licensed Investigator and the Radiation Safety Officer as soon as possible; do not leave scene of accident; call for assistance; do not allow any personnel not involved to enter.

4. Use absorbent material to contain spill. If spill is too large for this, wait at accident perimeter for assistance.

5. Decontamination of contaminated surfaces will be accomplished with floor washing detergent containing 3% EDTA.

EMERGENCY TELEPHONE NUMBERS

Campus Police	Emergency Ext.	**1-911**
	Emergency from Cell Phone	(413)538-2304
	Routine Ext.	2304

Radiation Safety Officer	(413)323-9571
Environmental Health and Safety	2529 (after hours call Campus Police for contact)
Mass. Radiation Control Program	(617)242-3035
Mass. Radiation Control Program Emergency #	(617)242-3453

Laboratory Safety Reminders

July 2012 ♦ Mount Holyoke College – Environmental Health and Safety

Safe Use of Radioactive Materials in MHC Research Labs

Research Protocols

A Radioactive Materials (RAM) use Protocol is a "step by step" procedure you will use when performing any experiment using radioisotopes. Your faculty advisor must evaluate your planned use of RAM for many hazards including: external dose, internal uptake, release of RAM into the lab or to the environment, contamination potential, use of RAM in animals, need for personnel dosimeter, etc.. The Radiation Safety Officer (RSO) reviews all RAM use procedures with the faculty member to ensure safe use and compliance with the College license to use RAM. The Radiation Safety Committee also approves each protocol.

Safety Training Required

After the safety evaluation of the Protocol and approval by the Committee, your faculty advisor will meet you in the lab and review the Protocol. At this meeting, you will learn lab techniques to prevent/minimize uptake, external exposure, contamination, etc.. You may also practice techniques using non-radioactive materials. **No student researcher may use RAM until they have received specific radiation safety training from their faculty advisor.** The College license mandates this specific safety review/training procedure.

Exposure Levels

ALARA is an acronym for "as low as reasonably achievable". Faculty and students must plan and conduct their research using RAM to ensure they have taken all precautions necessary to minimize their exposure to radiation to well below regulatory limits, i.e., as low as reasonable achievable, by using approved procedures and engineering controls to prevent exposures.

State regulations establish occupation exposure limits, which are described in the MHC Laboratory Safety Handbook. The Handbook also described special requirements for prenatal exposure. If you are or become pregnant while working with radioactive materials, consult the Handbook for details.

Storage of RAM

All RAM received from vendors and experimental samples generated must be stored in a secondary container, e.g., a labeled plastic box with a cover, before placing RAM in the refrigerator or freezer for storage. This is important to **prevent the spread of RAM contamination** in the lab refrigerator. Control of RAM to prevent contamination is one of your primary concerns as a student researcher using RAM.

RAM Use Area or Lab

Specific areas must be designated for RAM use and RAM cannot be used in any other areas of the lab. All RAM use areas, e.g., bench tops, sink, refrigerator, hood, etc., must be properly marked with "Caution Radioactive Material" tape and signs. The area must also be prepared for spills with plastic backed paper (two layers) and/or spill trays with elevated sides. **Use of long half-life isotopes, e.g., H-3, C-14, must be done on trays only** to reduce the amount of contaminated bench paper. This greatly reduces the cost of off-site RAM waste disposal.

Campus
Emergency Number
1911
(cell phone or off-campus: 413-538-2304)

If you will be using mCi quantities of high energy beta/gamma emitting isotopes, you must use a work bench plexiglass shield. Shields are clear, leaded and multilayered and greatly reduce the exposure rate. Your faculty advisor will install the appropriate shield for your planned RAM work and any other special equipment/shields to minimize exposure.

Posting and Labeling

The RSO posts all license required signs in your lab including labeling of your RAM waste containers. You must label all your research generated RAM containers with "Caution Radioactive Material" tape. Many research containers are very small and are difficult to label with tape. It is acceptable to label the tray or plastic storage box you are using to store small vessels in your refrigerator or freezer.

Proper Protective Clothing

All RAM users must wear a lab coat, safety glasses, and "appropriate" gloves, i.e., the gloves must be impervious to the solution in use. If improper gloves are selected for the solution in use, radioisotopes can pass through the glove and onto the skin. In fact, the solution may pass through the skin and also result in an internal uptake of RAM.

Since the potential for a spill of RAM onto the lab floor is high, users should also wear long pants with closed shoes (heel and toe with no perforations) and socks. If necessary during hot summer months when shorts and sandals are worn to the lab, keep a pair of old pants and shoes/socks in the lab for use in RAM procedures. If you spill RAM and it splashes on your lower leg, you then only need to remove and bag your old clothing. This will save you and your advisor from performing a long and tedious decontamination of your skin/lower legs.

If you have contaminated your lab coat, e.g., on the chest or arms, during routine procedures and the level is below a few thousand cpm (counts per minute), you may still continue to use the coat in your research with RAM. Low energy beta emitting isotopes, e.g., H-3, C-14, S-35, won't penetrate your coat. This same small level of high energy beta emissions, e.g., short half-life P-32, is greatly reduced by cloth lab coats and will result in insignificant does to your skin or arms.

If you find significant contamination on your coat during monitoring when using isotopes for which monitoring is appropriate, e.g., 10,000 cpm or greater in any one location, bag, date, label, and store the coat for 10- half-lives and get another coat to wear during your RAM research. If you know you contaminated your coat with H-3 or C-14, which you can't monitor, ask your faculty advisor for advice. You may need to dispose of the coat as radioactive waste.

Personnel Dosimeters

Dosimeters measure exposure during use of radioisotopes. Not all users are issued dosimeters. Low energy beta emissions, e.g., from H-3, C-14, S-35, are so weak they cannot penetrate the dosimeter encasement and therefore are ineffective and not issued.

If you have been assigned a whole body and/or ring dosimeter (or "badge"), you must wear it during research while working with the radioisotope specified, e.g., P-32. The ring dosimeter must be worn with the ring "face" on the palm side of the hand most likely to hold containers of RAM and under your protective glove. If you wear the ring with the face side toward the back of your hand, your hand will shield the radiation from being measured. Your body dosimeter can be worn on your lab coat at the chest pocket.

When you are not wearing your dosimeter, you must store it in a designated location in your lab. You must also monitor your dosimeter before you place it in the storage location to ensure that it is not contaminated. If you find that your dosimeter is contaminated, notify your faculty advisor immediately. Another dosimeter will be issues to you.

Never wear another person's dosimeter. If you receive a dose during research work, the dose will be assigned to the person assigned that

dosimeter. If you lose your dosimeter, notify your advisor and another will be assigned to you. If you unknowingly take your dosimeter home and it is laundered, notify your advisor and a replacement will be issued to you.

Ordering/Receiving RAM

Only faculty authorized by the Radiation Safety Committee may order RAM. Only the faculty member and their trained assistants may receive and open RAM packages.

RAM Waste Disposal

Briefly, the following methods are approved for RAM disposal. Faculty will establish specific procedures in the lab in consultation with the RSO.

1. Aqueous liquids discharged into the lab sink drain (be sure the sink drain is not leaking).
2. Solid contaminated lab materials are placed into properly marked waste containers with lids. All solid waste must be segregated by isotope, except H-3 and C-14 and other long half-life (>90 days) isotopes that may be placed in the same container.
3. Liquid scintillation cocktail (LSC) vials separated by isotope, except H-3 and C-14 may be placed in the same container as solid waste.
4. Non-toxic LSC vials must be separated from hazardous LSC vials.

RAM must never be disposed of into the normal lab trash can!! Monitor all lab waste carefully to make sure it is properly separated when you are using RAM.

Monitoring Your RAM Use Area

Most radioisotopes used in biological research emit beta particles, H-3, C-14, and P-32. A few also emit x-rays and/or gamma rays in addition, e.g., Cr-51, Fe-55. High energy beta emitters are easily monitored using a GM survey meter. Low energy beta emitters (e.g., C-14, S-35) can be detected with a GM survey meter at very low efficiency, i.e., about 4% or only if 10,000 dpm (disintegrations per minute) or more activity is present. Therefore, a work surface wipe test must be performed to ensure that you will detect any contamination present by using the liquid scintillation counting (LSC); H-3 can only be detected using LSC.

You must have the appropriate monitoring equipment in your lab or have immediate access to the equipment to ensure that you will make the proper contamination surveys in your RAM use area. **At a minimum, you must monitor your work area following completion of each RAM use/experiment.** You must also monitor your work area at various intervals during long experiments, e.g., while waiting for samples to complete centrifugation, water bath treatment, etc., or whenever you suspect contamination is probable.

When using the GM survey meter, use only the "CPM" scale to determine the contamination level along with the efficiency found on the calibration sticker. The mR/hr scale is not calibrated and has no meaning.

Spill Response

You must report all spills or contamination to your faculty advisor as soon as possible.

If you know you have **contaminated your skin**, you should go to the lab sink and wash the area with warm water and liquid hand soap. Then dry the area and monitor with the GM meter. Repeat this until the area of the sink contamination is at background, but no more than 3 times. **You must not redden or break the skin** by rubbing too hard. If there is residual contamination remaining after 3 cleaning attempts, your advisor and the RSO will evaluate the dose from remaining contamination, a requirement of our License, and discuss it with you.

If the radioisotope spilled on your skin is H-3, no external dose is possible, i.e., the beta emission is too weak to penetrate your dead skin layer. However, any isotope can penetrate the skin if the solution spilled on the skin can penetrate, as through a cut or other opening in the skin, or if the solution is a chemical that is skin absorbed. Your advisor will call the RSO for additional assistance on any spill if deemed necessary.

If a small RAM spill occurs that you know just happened, the first step in dealing with it is to visually check yourself for spill splash. Tell others in the lab to not come into the area of your spill until you have monitored and cleaned the area. Notify your faculty advisor for supervision/assistance in cleaning up the spill.

If the spill is small and you are not contaminated, absorb (don't spread the liquid with the usual wiping motion) the liquid with Kim-Wipes or paper towels. Then spray the spot with Dow Spray Cleaner and re-blot with paper towel. Monitor the area and surrounding area carefully to be certain that all are at background level. Re-clean and remonitor as necessary to complete the clean-up. **If the spill is large, call for help immediately.**

You should never be working in the lab alone, however, if you are alone and need help, try calling out for help; if this is unsuccessful after repeated tries, take off your gloves and walk slowly to the phone to call your faculty advisor or Campus Police**; stay put until help arrives, to limit the spread of contamination**. Emergency phone numbers are posted in the lab or on the lab door.

Transport of RAM

You may transport RAM between labs as long as your faculty advisor has approved transport. The RAM must be placed into an unbreakable secondary container, e.g., a plastic box with a snap lid or a styrofoam box with the lid taped down, to ensure that no RAM will be spilled during transport. **Transport of RAM to any other location is strictly prohibited.**

For Emergency Assistance

Faculty Advisor:
(ask your faculty advisor for contact information and make sure it is posted in the lab)

Campus Police <u>Emergency</u> ext. 1911
<u>Campus Police Emergency from a cell phone (413)538-2304</u>
Campus Police (routine calls ext. 2304)

Assistant Radiation Safety Officer, Janice Hudgings, ext. 2206
To contact the Radiation Safety Officer Call: (413)323-9571
Office of Environmental Health and Safety, ext. 2529, or Campus Police, ext. 2304

MOUNT HOLYOKE COLLEGE
RADIATION SAFETY

PROTOCOL FOR THE USE OF RADIONUCLIDES

Please complete the following form and return to the **RADIATION SAFETY OFFICER.**

I. APPLICANT INFORMATION

Applicant Name:
Department:
Office (Building/Room #):
Radionuclide Lab (Building/Room #)
Email Address:
Telephone Number:

Type of Protocol:

Initial request:	Renewal:	Amendment to an existing protocol (complete amended sections only):

Signature below affirms that the applicant will comply with the regulations set forth by the Radiation Safety Committee regarding the use of radioactive materials as detailed in the Science Center Safety Handbook. In case of prolonged absence, termination, relocating of lab facilities, or any other change in use or storage, the applicant will inform the Radiation Safety Officer.

Signature:	Date :

II. RADIONUCLIDE(S) REQUESTED

Radionuclide	Maximum Activity On-Hand (mCi)	Est. Maximum Annual Purchase (mCi)	Form*

*Chemical and/or Physical Form: Liquid, Gas, Crystalline, Powder, Sealed Source

If sealed source, Manufacturer and Model #:

If material is received as a powder, will it be dissolved in shipping vials?	
Radiocnuclide	Yes/No

Will Radionuclide(s) be incorporated into a toxic or hazardous compound? If the answer is yes, outline the safety precautions in Item VII.		
Radiocnuclide	Yes/No	Hazardous compound(s)

Are any of the following used in the protocol? If the answer is yes, outline the safety precautions in Item VII.		
Radiocnuclide	Yes/No	Compound(s)/Agent(s)
Infectious Agent		
Acute Toxin		
Select Carcinogen		
Reproductive Toxin		
Reactive Chemical		

Will animals be used:		
Yes/No	Species	IACUC Approval Status

III. FACILITIES AND EQUIPMENT FOR HANDLING RADIONUCLIDES

	Location
Hood	
Survey Meter Detector Type:	
Liquid Scintillation Counter	
Gamma Scintillation Counter	

IV. RADIATION SAFETY PROCEDURES

Radiation safety procedures shall be conducted in accordance with the Chapter VII(a) of the Science Center Safety Handbook.

Equipment to be Used	Yes/No	Type (if applicable)
Film Badges/Rings		
Lab Coats		
Disposable Gloves		
Spill Trays		

Waterproof Backed Absorbent Material for bench/floor		
Pipette Device		
Signs and Labels		
Shielding Material		
Other		

	Yes/No	Description/Comments
Have you made arrangements with Radiation Safety for posting radionuclide laboratory(s) with the required forms and signs in conspicuous places?		
Have you obtained a copy of the Radiation Safety Manual (Safety Handbook VII(a))?		
Are you familiar with the emergency procedures as outlined in the Radiation Safety Manual?		
Will your procedure present potential radiation hazards requiring special attention? (If yes, please specify)		
Have you developed procedures for performing and recoding periodic radiation surveys of your facilities?		
Is there any possibility of a radioactive gas release?		

V. DECONTAMINATION PLANS

Detail plans for decontamination in case of accident? Please give procedure planned for each radionuclide:

VI. WASTE DISPOSAL

	Yes/No	Description/Comments
Do you have a record keeping system that will enable you to document receipt and disposition of radioactive materials?		
Have you read the Procedures for Handling Radioactive Waste?		
Have you made arrangements with Radiation Safety to obtain appropriate radioactive waste containers and do you have the proper materials for packing solid and liquid wastes?		
Have you planned for a record keeping system to enable you to correctly label waste containers as to radionuclide, date and quantity?		
If using animals, have you made provisions from frozen storage of carcasses prior to pickup by the disposal service?		
Is there a chance of controlled our uncontrolled release of volatile radioactive waste from experimental procedures?		

If there is a chance of controlled our uncontrolled release of volatile radioactive waste from experimental procedures, provide detailed information on control measures.

VII. PROPOSED RESEARCH

Outline proposed research with details on the procedure for handling <u>each</u> radionuclide. Include such items as maximum activity to be handled at one time, activity per animal, etc. Elaborate on methods of containing potential releases to air of water. As an alternative to describing on this form, you may attach your research protocol.

VIII. INDIVIDUAL USERS

List **all** persons other than the applicant who will use or be exposed to radiation under this authorization. **They must receive training prior to being exposed to any radiation.** Contact Radiation Safety concerning film badge monitoring of exposures.

Name	Faculty/Student/ Staff/Other?	Radionuclide(s) Being Used

IX. TRAINING AND EXPERIENCE (only required for first time applicants)

Record your experience and training in detail, listing each training period separately. State where training was obtained, its duration, and whether it was formal, or on-the-job; give inclusive dates. If Part B has been completed on a previous application, it may be omitted, unless pertinent new information is available.
Principles and practices of protection:
Radioactivity measurements and monitoring techniques; instrumentation:
Mathematics and calculations, basic to measurement of radioactivity:

Biological effects of radiation:
Pertinent other training, include college and university courses, degrees obtained, with dates and subjects:

List each type of experience separately. List radioactive materials separately or in logical groups, showing maximum amounts used, installation where experience was gained, duration of experience, and type of use:

Mount Holyoke College

Radiation Purchase and Receipt Report

Section I: ORDER INFORMATION

Complete when the order is placed, and provide information by email, email attachment, or paper copy to the Radiation Safety Office and the Science Center Stockroom Manager the same day the material is ordered.

Investigator:	Date of Order:
Vendor:	Expected Delivery Date:
Catalog #:	P.O. #

Isotope:	Activity:
	Form:

Section II: PACKAGE MONITORING UPON RECEIPT

Complete when the package is received and opened. Submit as an email attachment or paper copy to the Radiation Safety Officer.

Radiation Measurements	
Date:	Package Condition:
At Surface:	One Meter from Surface:
Instrument Used:	Instrument Background:
Surface Wipe Test:	Wipe Test Background:
Instrument Used:	
Package Disposition:	

_____

Investigator Signature

_____

Date

Mount Holyoke College
Radiation Safety Personnel Training Record

Researcher's name: _____

MHC ID #:_____

DOB: _____
[Must be 18 years or older]

Staff/ Student/Faculty: _____ Class Year: _____

Name of Investigator: _____

I have received training in the use of _____

This training included the following topics:

- Risks from Occupational Radiation Exposure
- Procedures necessary to minimize exposure
- Purpose and function of protective equipment, monitoring equipment, and personnel dosimeters
- The Mount Holyoke College Radiation Protection Program
- License conditions and/or State regulations governing the use of RAM and/or radiation producing machines
- General radiation safety practices
- Procedures for safety opening packages (Appendix D)
- Emergency response procedures (Appendix E)

and I was given a copy of Appendix F — Safety Use of Radioactive Materials in MHC Research Labs.

I understand the health risks associated with radiation exposure and the precautions necessary to minimize my exposure and/or uptake. I accept the responsibility of performing my assignments in accordance with the procedures of the Mount Holyoke College Radiation Protection Program and those taught to me by authorized faculty members.

Signature of Researcher: _____

Date: _____

Signature of P.I.: _____

Notes:

Send a copy of this Training Record to Environmental Health and Safety

Group 1 Recommendation of the ICRP-Report V;Pergoman Press, New York, N.Y. (1965).								
Pb-210	Po-210	Ra-223	Ra-226	Ra-228	Ac-227	Th-227	Th-228	Th-230
Pa-231	U-230	U-232	U-233	U-234	Np-237	Pu-238	Pu-239	Pu-240
Pu-241	Pu-242	Am-241	Am-243	Cm-242	Cm-243	Cm-244	Cm-245	Cm-246
Cf-249	Cf-250	Cf-252						
Group 2 Recommendation of the ICRP-Report V;Pergoman Press, New York, N.Y. (1965).								
Na-22	Cl-36	Ca-45	Sc-46	Mn-54	Co-56	Co-60	Sr-89	Sr-90
Y-91	Zr-95	Ru-106	Ag-110m	Cd-115m	In-114m	Sb-124	Sb-125	Te-127m
Te-129m	I-124	I-126	I-131	I-133	Cs-134	Cs-137	Ba-140	Ce-144
Eu-152 (13y)	Eu-154	Tb-160	Tm-170	Hf-181	Ta-182	Ir-192	Tl-204	Bi-207
Bi-210	At-211	Pb-212	Ra-224	Ac-228	Pa-230	Th-234	U-236	Bk-249
Group 3 Recommendation of the ICRP-Report V;Pergoman Press, New York, N.Y. (1965).								
Be-7	C-14	F-18	Na-24	Cl-38	Si-31	P-32	S-35	Ar-41
K-42	K-43	Ca-47	Sc-47	Sc-48	V-48	Cr-51	Mn-52	Mn-56
Fe-52	Fe-55	Fe-59	Co-57	Co-58	Ni-63	Ni-65	Cu-64	Zn-65
Zn-69m	Ga-72	As-73	As-74	As-76	As-77	Se-75	Br-82	Kr-85m
Kr-87	Rb-86	Sr-85	Sr-91	Y-90	Y-92	Y-93	Zr-97	Nb-93m
Nb-95	Mo-99	Tc-96	Tc-97m	Tc-97	Tc-99	Ru-97	Ru-103	Ru-105
Rh-105	Pd-103	Pd-109	Ag-105	Ag-111	Cd-109	Cd-115	In-115m	Sn-113
Sn-125	Sb-122	Te-125m	Te-127	Te-129	Te-131m	Te-132	I-130	I-132
I-134	I-135	Xe-135	Cs-131	Cs-136	Ba-131	La-140	Ce-141	Ce-143
Pr-142	Pr-143	Nd-147	Nd-149	Pm-147	Pm-149	Sm-151	Sm-153	Eu-152 9.2 hr
Eu-155	Gd-153	Gd-159	Dy-165	Dy-166	Ho-166	Er-169	Er-171	
Tm-171	Yb-175	Lu-177	W-181	W-185	W-187	Re-183	Re-186	Re-188
Os-185	Os-191	Os-193	Ir-190	Ir-194	Pt-191	Pt-193	Pt-197	Au-196
Au-198	Au-199	Hg-197	Hg-197m	Hg-203	Tl-200	Tl-201	Tl-202	Pb-203
Bi-206	Bi-212	Rn-220	Rn-222	Th-231	Pa-233	Np-239		
Group 4 Recommendation of the ICRP-Report V;Pergoman Press, New York, N.Y. (1965).								
H-3	O-15	Ar-37	Co-58m	Ni-59	Zn-69	Ge-71	Kr-85	Sr-85m
Rb-87	Y-91m	Zr-93	Nb-97	Tc-96m	Tc-99m	Rh-103m	In-113m	I-129
Xe-131m	Xe-133	Cs-134m	Cs-135	Sm-147	Re-187	Os-191m	Pt-193m	Pt-197m
Th-232	Th-Nat	U-235	U-238	U-Nat				