



BOISE STATE UNIVERSITY

Environmental Health, Safety and Sustainability

RADIOACTIVE MATERIALS

MANAGEMENT MANUAL

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Pertaining to NRC Materials License #11-27388-01

Table of Contents

	Page
Section I--- Regulatory Authority.....	
Section II--- Composition and Roles of Members.....	
Section III--- General Administrative Procedures.....	
Section IV--- Protocol Review and Approval.....	
Section V--- Recordkeeping.....	
Section VI, part a--- Authorized Users.....	
Section VI, part b--- Radiation Safety Officer.....	
Section VI, part c--- Individual Users.....	
Section VII--- Training.....	
Section VIII--- Storage and Disposal of Radioactive Wastes.....	
Section IX, part a--- Labeling, Shielding, Monitoring.....	
Section IX, part b--- General Safety Rules.....	
Section IX, part c--- Emergency Procedures.....	
Appendix I--- Dose Limits and ALARA	
Appendix II--- Concentrations in Air and Water Above Natural Background (10CFR20)	

Section I---Regulatory Authority

Boise State University maintains a radioactive materials management program to ensure that the use of ionizing radiation in research and classrooms at the University does not result in unnecessary exposure of individuals. Compliance with the applicable Code of Federal Regulations (10 CFR 20, <http://www.nrc.gov/reading-rm/doc-collections/cfr/part020>) and the Radioactive Materials License issued to Boise State University is governed by the Nuclear Regulatory Commission. The program is managed by the Radiation Safety Officer with oversight by the Radiation Safety Committee. The Committee is charged with the responsibility for establishing and applying proper radiation use and safety procedures. This Radioactive Materials Management Manual issued by the Committee serves to guide University faculty, staff, students and the public regarding compliance with radiation safety requirements.

Federal regulations require that exposure of persons to radiation remain As Low As Reasonably Achievable (ALARA). The University intends to make every reasonable effort to maintain exposures to radiation as far below the regulatory dose limits as is practical and consistent with the purpose for which the licensed activity is undertaken. The following procedures and requirements identify minimum steps to be taken by all who are associated with the use of radioactive materials at Boise State University.

Section II---Composition and Roles of Members

1. At the Boise State University campus there shall exist a Radiation Safety Committee (RSC). The RSC will be composed of the Radiation Safety Officer (RSO) and Authorized Users specifically named in the NRC Materials License to use radioactive materials.
2. The Radiation Safety Program will be carried out by the RSO with appropriate oversight and assistance by the RSC. The RSO will act as chair of the RSC.
3. A staff member from the Environmental Health & Safety office will serve as the RSO.
4. The RSC shall have final responsibility for approving or disapproving recommendations of the RSO regarding proposed amendments to the radioactive materials license, the use of radiation sources, the establishment of safety procedures and the specifications of radiation handling facilities, in accordance with applicable federal and state regulations.
5. The RSC must approve any modifications to the Radioactive Materials Management Manual.
6. The RSC shall make recommendations to the appropriate department head and/or Vice President for Research regarding suspension of any person who is subject to the procedures and requirements of this Manual from the use of radioactive materials in the event that the actions of that person unnecessarily jeopardize the safety of others. Recommendations for reinstatement of such privileges shall also be made by the committee when appropriate.
7. Meetings of the RSC may be called for by any member upon due notice to the chairman. Meetings require the presence of a quorum (50% + 1) of RSC members. All decisions shall prevail by majority vote of those members actually present.

Section III--- General Administrative Procedures

1. This Radioactive Materials Management Manual shall be made available to all Principal Investigators who will hold responsibility for assuring that all persons under his/her direction who use radioactive materials are knowledgeable regarding its contents.
2. All persons employed by or associated with Boise State University, including faculty, staff, guest researchers, regular students, and visiting students, who use ionizing radiation on campus or in off-campus facilities shall adhere to the procedures and requirements described in this Manual and also applicable federal and state regulations. Please see visit the EHSS website and click on [Radioactive Materials Management Manual](#).
3. No radioactive material may be brought onto or removed from the Boise State campus without the express permission of the RSO.
4. In case of a radiation emergency, the RSO may take immediate steps to limit the exposure to individuals or the release of radiation in any facility of the University. The RSC shall be notified as soon as possible of the emergency action.

Section IV--- Protocol Review and Approval

Who Must Submit a Radiation Safety Protocol

Any testing, research, or instructional use of radioactive material by Boise State faculty, researchers, staff, or students requires the submission of a Radiation Safety Protocol to the Radiation Safety Officer who will distribute the submission to the Radiation Safety Committee (RSC). Please contact the RSO for information on submitting a protocol.

CRITERIA FOR REVIEW AND APPROVAL FOR PROTOCOL

There are several criteria that need to be taken into account with each protocol. The following are required components that the RSC will take into consideration for their review:

- (a) Statements on protocol application must be written in language understandable to the lay public about the purpose and relevance of the proposed study.
- (b) Standard operating procedures shall be submitted that detail the nature of the work with respect to radiation safety.
- (c) Summary of methodology, techniques and procedures of the project, including the aim or goals to be reached using the described methods.

THE PROTOCOL REVIEW AND APPROVAL PROCESS

A period of four to six weeks should be allowed for a protocol to be reviewed.

All protocols submitted to the University's RSC for approval, receive a full committee review. A full committee review is conducted by a quorum of the RSC. The purpose of a full committee is to have all RSC members involved in the review and decision-making on the disposition of protocols. This in turn allows the RSC to utilize the expertise of its members in a discussion-based format.

During the RSC meeting, no member may participate, in which the member has a financial and/or a conflicting interest (e.g., is personally involved in the project) except to provide information requested by the RSC; nor may a member who has a conflicting interest contribute to the constitution of a quorum. Protocols are approved for a maximum of three (3) years. After year three (3), the Principal Investigator (PI) will need to rewrite and submit the protocol to be reviewed as a new protocol.

Following the protocol submission (either electronic or written document), the RSO conducts the initial assessment to ensure all elements of the protocol are provided. At that same time, the protocol is assigned a number and entered into a database.

A. Protocol review process. Prior to the review process, each RSC member shall be provided with a copy of the protocol along with review and comment sheet, via email or US surface mail. Within two weeks of receiving the protocol, RSC members review the protocol and return their comments to the RSO. The comments will be emailed or sent via campus mail in order to ensure

the review process is conducted in a timely manner. The PI may be contacted by the RSO to respond to questions and/or make modifications to the protocol. Once all comments, questions and concerns are tabulated and summarized, they are sent to all RSC members for review. The protocol is then placed on the agenda for the meeting of the RSC. A summary of all comments will be duplicated and presented at the meeting for review and discussion.

B. Approval for all protocols. Approval of a new protocol or a current protocol submitting modifications or significant changes may be granted only after review at a convened meeting of a quorum of the RSC and with the approval vote of a majority of the quorum present.

C. Approval for triennial/continuing review protocol. If the information was complete in the last approved protocol and there are no significant changes or modifications to that information, the triennial/continuing review protocol is sent to three (3) reviewers, with a rotating schedule of committee members. The RSO will try to select one committee member from the three, with expertise/experience related to the project/research area that is being renewed. If there are significant changes indicated in the renewal, then the protocol must specifically identify them and state the reasons for the changes. At least sixty (60) days prior to the triennial date of an approved protocol, the RSO will send a renewal notice to the Principal Investigator (PI). The PI has the primary responsibility to ensure the triennial review is submitted in a timely manner.

D. Notification: Following each RSC meeting, the RSO will notify the PI in writing of its decision to approve or withhold approval of the proposed protocol.

Categories of Action

Full approval of the protocol. The RSC has determined that all review criteria have been adequately addressed by the PI, thus providing the Principal Investigator permission to perform the protocol and procedures as described.

Note: An RSC approved protocol may be subject to further appropriate review and approval by University Officials due to financial, policy, facility, environmental, or safety considerations. However, those officials may not grant full approval of an activity if it has not been approved by the RSC.

Approval of modifications to the protocol. If the RSC determines that a protocol is approvable contingent upon receipt of specific minor modifications (e.g., procedure will be conducted under fume hood, or clarification of a specific point) the RSC will consider these as administrative details and once clarified will consider the protocol approved as earlier designated by the RSC.

Suspension of active protocol. The RSC shall make recommendations to the appropriate department head and/or Vice President for Research regarding suspension of any person who is subject to the procedures and requirements of this Manual from the use of radioactive materials in the event that the actions of that person unnecessarily jeopardize the safety of others. Recommendations for reinstatement of such privileges shall also be made by the committee when appropriate. The RSO may temporarily suspend work with radioactive materials if an imminent health hazard exists.

Section V---Recordkeeping

Principal Investigators/Authorized Users (identified by the License) are responsible for procurement of radioactive materials for their own use. No other person may procure radioactive materials for use on the Boise State University campus or at other University facilities. The following procedures are established for ordering, receiving, and recording the use/disposition of radioactive materials. These procedures apply to the purchase of radioactive materials and also to the receipt of radioactive material from other institutions and entities on a no-charge or loan basis.

Ordering and Maintaining Inventory Records of Radioactive Materials

1. The procurement and use of radioactive materials is tracked by completion of the Boise State **“Radioactive Material Record”**, a triplicate form that may be obtained from the RSO.
2. Prior to ordering radioactive material, the PI shall telephone or e-mail the RSO to identify the amount (activity) of an isotope intended to be purchased and to request a **Control Number**, which shall be recorded on the **Radioactive Material Record**. The control number will be issued if the isotope does not exceed the licensed quantity (if the order will cause the aggregate licensed limit to be approached, the other PIs will be informed). **Radioactive materials may be ordered through the normal Boise State requisition process, but not until a control number has been issued.** Control numbers will be given the following codes:

<u>Isotope</u>	<u>Numerical Series</u>
P-32	P1000
S-35	S2000
C-14	C3000
H-3	T4000
Hg-203	H5000
Am-241	A6000
I-125	I7000
Ni-63	N8000
DU	DU9000
U-233	U31000
U-235	U51100
U-236	U61200
U-238	U81300
Pb-202	P21400
Pb-205	P51500

Receiving Radioactive Materials

Packages of radioactive materials will be delivered to the chemical stockroom or receiving area of the respective College or Department. The following procedure shall prevail.

1. The receiving area personnel shall examine the package for visible damage or leakage (if significant damage or any leakage is apparent, the package shall be returned to the transporter and the RSO immediately notified).

2. The receiving area personnel shall notify the Authorized User (AU) who ordered the material of the receipt of a package.
3. The AU shall pick up the package at the receiving area.
4. The AU shall wipe test the package for removable surface radiation before opening (measured in dpm). For beta, gamma and low toxicity alpha emitters, if removable surface radiation exceeds 22 dpm/cm² (or 10⁻⁵ uCi/cm²), the package shall be stored and the RSO immediately notified for determination as to the disposition of the package.
5. The top part of the **Radioactive Material Record** shall be filled out when the material is received and wipe tested. The **pink** (third) copy of the form is then sent to the RSO.
6. The AU shall clearly label the radioactive material container with the appropriate control number.

Record of Use of Radioactive Materials

1. Any aliquots of the material taken from the vial/container; or when a foil source is inserted or removed, shall be recorded on the **Radioactive Material Record** along with the method/nature of final disposition.
2. When all of the radioactive material identified by the control number has been used and/or disposed of, the **yellow** (second) copy of the form shall be sent to the RSO and the **white** (first) copy of the form shall be kept by the AU.
3. Leak tests of sealed sources shall be performed as per manufacturer's recommendation and registry. The RSO shall be notified prior to the start of the leak test.

Section VI, part a--- Authorized Users

The Authorized Users (AUs), also recognized as Principal Investigators (PIs), identified in the License, are responsible for:

1. Procuring radioactive materials in accordance with approved procedures.
2. Adhering to all requirements contained within this manual, the License, and applicable state and federal regulations.
3. Developing protocols and Standard Operating Procedures specific to the use of radioactive materials in his/her laboratory, including rules for opening and handling of containers; handling, marking, and washing of glassware and other containers; use of dosimeters; use of gloves and other protective clothing; surveys; procedures for containing and cleaning up spills; and use of shielding and hoods when appropriate.
4. Training and direct supervision of all persons using radioactive materials in his/her laboratory to ensure that all exposures to radiation are kept as low as reasonably achievable.
5. Determining potential radiation doses and actual doses to personnel.
6. Posting required signs and labels on radioisotope containers, storage locations, and areas of use.
7. Conducting monthly surveys of facilities to determine levels of contamination.
8. Ensuring proper storage and disposal of radioactive wastes.
9. Maintaining records of radioactive materials procurement, use, surveys and personnel exposure.
10. Providing information to personnel regarding radiation exposure.

Section VI, part b--- Radiation Safety Officer

1. The RSO shall retain the original NRC Materials License, provide copies of the license to departments as appropriate, submit proposals for license amendment to the NRC, and coordinate the process of application for renewal of the license.
2. The RSO shall prepare and keep current the Radioactive Materials Management Manual, outlining the radioactive materials use and safety program at the University.
3. The RSO shall be responsible for supervising the safe use and handling of radioactive materials on the Boise State campus and ensuring ALARA exposure of individuals. Requisite duties include:
 - a. Ensuring that all persons who use radioactive materials are trained in the safe use and handling of such materials.
 - b. Review of protocols for the use and handling of radioactive materials to ensure the lowest practicable exposure to individuals.
 - c. Recommendation of operational procedures and safety precautions to ensure the lowest practicable radiation exposure of individuals.
 - d. Conducting a semi-annual inventory of all sources of ionizing radiation on campus.
 - e. Maintenance of an inventory record system for all sources of ionizing radiation present on, entering or leaving the Boise State campus.
 - f. Maintenance of a personnel exposure record for certain persons using sources of

- ionizing radiation.
- g. Maintenance of equipment for carrying out external radiation monitoring for all sources.
 - h. Maintenance of a regular but unscheduled system of inspection of all areas where radioactive materials are in use under license to ensure that the routine operations comply with the provisions of the manual and applicable federal and state regulations. The frequency of inspection shall be annually at a minimum, but will be a function of the total activity and the nature of the radioisotopes handled in each laboratory and the degree of noncompliance determined by previous inspections.
 - i. Maintenance of radioactive waste disposal records in compliance with regulations.

Section VI, part c---Individual Users

Each individual who at any time has control over a source of ionizing radiation is responsible for the safe handling of the material and for limiting exposure of himself/herself and others to as low level as practicable. Individuals shall comply with the following general rules/practices and those which are stated or reiterated in Section IX, part b:

1. Smoking, eating, drinking, and storage of food/drinks in radioisotope laboratories is not allowed.
2. Oral pipetting of radioactive solutions is not allowed.
3. Personal protective equipment shall be used as determined by the PI.
4. Dosimeters shall be worn as prescribed by this manual or by the PI.
5. Individuals shall participate in the personnel monitoring program including thyroid scans and the furnishing of urine samples upon request when such procedures are established by this manual or the rules of a specific laboratory.
6. Individuals shall complete any training prescribed by this manual, the PI, or by the RSO.
7. **Pregnant women are responsible for informing their Principal Investigator of the condition. Declared pregnant individuals may receive only 10% of the normally allowed occupational dosage of radioactivity.**
8. All individuals who handle radioactive materials are responsible for reading and understanding this section of this manual, all other applicable sections identified by the PI or RSO, and all relevant rules pertaining to a specific laboratory.

Section VII---Training

Individuals who will use radioactive materials in their classroom or research activities must be properly trained to use the materials safely. Individual PIs must provide specific safety instructions for the use of the particular isotope in his/her laboratory. The degree of safety supervision provided to each student during a specific activity shall be determined by the PI, but at least one other person trained in the use of radioactive materials must be in the area when a student is using radioactive materials. In addition, before a student may work with radioactive materials, he/she must view the radiation safety videos at the office of the Radiation Safety Officer. Each student shall:

1. Contact the RSO office (phone 426-3906) to view the videotapes.
2. Read the Boise State [Radioactive Materials Management Manual](#).
3. Complete and pass a quiz on the subject of radiation safety.
4. Complete a form stating that the videos have been viewed and the quiz passed. The RSO will sign the form; a copy will be sent to the PI in whose laboratory the student will work. The RSO will maintain a list of students who are authorized to use radioactive materials.
5. Receive training on recordkeeping from the RSO.

Each minor student (individual under the age of 18) shall submit to the RSO and the PI a letter of parental consent to use radioactive materials under the supervision of the PI. The letter will state that the parent understands that the minor will use radioactive materials in a research or classroom environment. The level of radioactivity used by minors will be kept at the absolute minimum while conducting experiments. **Minors may receive only 10% of the normally allowed occupational dosage of radioactivity.**

Section VIII---Storage and Disposal of Radioactive Wastes

Principal investigators are responsible for collecting and storing all radioactive wastes arising from activities under their direction. Liquid, solid, and animal wastes must be maintained separately. The AU may dispose of certain wastes, while the RSO will arrange for disposal of certain other wastes. The following procedures shall be followed.

Segregation of Radionuclides

C-14 and H-3 may be stored and disposed of together. **All other nuclides must be held in separate containers.** Radioactive waste must also be segregated according to physical form (dry solid, liquid, gas, or animal) and chemical form (i.e., aqueous or non-aqueous liquids).

Waste Containers

Each laboratory generating radioactive wastes should be equipped with at least one container for solid waste and one unbreakable container for liquid waste. Containers used for radioactive waste must be conspicuously labeled with the radiation symbol and the words CAUTION--RADIOACTIVE MATERIAL.

Solid Dry Waste: All dry wastes may be placed in standard plastic or metal trash cans fitted with disposable, waterproof polyethylene liners. Slightly damp gloves or wipe tissues may be placed in dry waste containers (if it drips, there is too much liquid). All sharps and broken glass must be placed in a puncture-proof container before being added to the dry waste.

Liquid Waste: All liquid waste must be placed in tightly capped, unbreakable bottles. Contents of waste containers should not exceed 3/4 full.

Liquid Scintillation Counting Vials and Fluids: Separate exempt waste (scintillation media containing less than 0.05 uCi/g H-3 and C-14) from other wastes generated. Toxic organic scintillation solvents must be separated from aqueous wastes. Waste scintillation fluid that is to be managed by storage and decay should be kept in the vials rather than combined into a single container.

Biological Wastes: Biological wastes, including animal carcasses, require storage separate from other non-radioactive biological material. Preferably, they should be frozen in sealed plastic containers with proper labeling (e.g., isotope, date, estimated activity).

Disposal

Principal investigators may personally dispose of radioactive wastes through storage and decay or through dilution and discharge to the public sewer when those practices are allowed by federal regulations. All other radioactive wastes will be disposed of by a commercial vendor, arrangements for which will be made by the RSO.

Storage and Decay: Waste containing short-lived isotopes (half-life less than 65 days, but including S-35, half-life 87.4 days), may be managed by storage for at least **10 half-lives**, followed by disposal as general solid or liquid waste. Before disposal, material must be surveyed to demonstrate that radioactivity cannot be distinguished from background. Radiation labels shall be removed or obliterated before disposal. When wastes are managed by storage and decay, the AU must complete a **Boise State Radioactive Material Disposal Record** (form) for wastes identified by each control number. **A copy of the completed form must be sent to the RSO (in addition to the Radioactive Material Record, which will have been sent earlier).**

Disposal to Public Sewer: Longer-lived isotopes that are readily soluble or dispersible in water (and de minimis amounts of short-lived isotopes, such as rinsates) may be diluted and discharged to the public sewer at sinks within the research laboratories. The wastes shall be diluted **before** discharge to the sewer as prescribed by NRC regulations (these are maximum monthly averages, but should be applied to any instantaneous batch discharge):

<u>Isotope</u>	<u>Dilute to:</u>
C-14	3×10^{-4} uCi/ml
H-3	1×10^{-2} uCi/ml

Measurable amounts of isotopes discharged to the public sewer must be accounted for on the **BSU Radioactive Materials Record**.

Section IX, part a---Labeling, Shielding, Monitoring

Signs: A CAUTION - RADIOACTIVE MATERIALS sign must be conspicuously posted on the doors to laboratory areas where radioactive materials are being used or stored. The name and home phone number of the individual responsible for the posted area shall be shown on the sign in order to facilitate contact in case of emergency. Storage areas shall be marked with a similar sign. Signs are not required (a) in areas or rooms containing radioactive materials for less than 8 hours if the materials are constantly attended, and (b) in areas where the radiation level at 30 centimeters from the surface of the source container does not exceed 0.005 rem (0.05mSv) per hour.

Labeling: Containers in which radioactive materials are stored shall bear a durable, clearly visible label bearing the radiation caution symbol and the words, CAUTION - RADIOACTIVE MATERIALS. This label shall also state the quantities and kinds of radioactive materials in the container, the date of measurement of quantity and the exposure rate at the outside of the container. Labels are **not** required for containers with less than the stated amounts of the following isotopes (however, it is recommended that any stored container of radioactive material be labeled):

C-14	1000 uCi
H-3	1000 uCi
I-125	1 uCi
P-32	10 uCi
S-35	100 uCi

Shielding of Sources

The type and amount of shielding that is necessary will depend on the amount of activity and the type of radiation involved. Shielding materials and/or devices shall be provided for use when high-energy beta (e.g., P-32) or gamma emitters are handled. The size and shape of these objects will depend on the nature of the work location, but they shall be such as to provide a sufficient thickness. Examples are 1/8 to 1/4-inch lucite (beta) and appropriate thickness of lead sheet or blocks (gamma).

Personal Monitoring Devices and Records: When the nature and quantities of the nuclides in use cause whole-body dose rates to be anything but obviously negligible, the authorized user is obligated to provide adequate and effective equipment and procedures for monitoring the doses accumulated by himself/herself and all others associated with the project or course of study. For the use in tracer quantities of such nuclides as H-3 and C-14, film badges and/or dosimeter pencils are useless and therefore not required. However, for P-32, I-125 and others of similar penetrating power (greater than 0.2 MeV), regular use of film badges or dosimeters is necessary. Devices for P-32 should include a finger ring monitor worn under a disposable plastic glove. **Records of the monitoring shall be kept by each PI and a copy of each record shall be sent to the RSO for permanent storage. If exposure to any individual is shown to reach 10% of the annual dose limits shown in Appendix A, the PI will investigate the reasons for the exposure and file a report with the RSO. Exposure records shall be made available to each individual. Selected radiation safety**

protocols and examples of dose calculations are shown in Appendix C. Personal monitoring is not necessary during extended periods when radioactive materials are not being used; however, the records of each PI shall note the occurrence of such periods.

Surveys: The immediate areas (e.g., hoods, bench tops) in which radioactive materials are being used should be checked for contamination after each use by the radiation workers in that area. Laboratory protective clothing and equipment used in radioisotope work areas shall be monitored routinely during the course of work and when work with radioactive material is temporarily or completely halted. Contaminated disposable clothing and equipment will be disposed of as radioactive waste. **A formal survey shall be conducted by the PI at least monthly during periods of radioactive material use and such surveys shall be observed by the RSO at least once annually. Records of the results of all checks for contamination and of all formal surveys shall be maintained by each PI. No survey is required for periods during which no radioisotopes are handled; however, a notation to that effect must be made in the records of the PI (no work, no survey).** Formal surveys shall consist of (a) wipe tests performed on representative 100 square centimeter areas in storage areas, hoods, on counter tops and on floors, and (b) scans of surfaces with survey instruments when appropriate (beta energy levels above 70 KeV and gamma emitters). **Survey instruments shall be calibrated annually.** The following levels of radioactive contamination on surfaces are not acceptable (**areas with greater contamination must be decontaminated by appropriate cleaning within one working day**):

1. Removable alpha activity detectable at the surface in excess of 10^{-7} uCi/cm²; 22 dpm per 100 cm² by wipe test.
2. Removable beta or gamma activity in excess of 10^{-6} uCi/cm²; 220 dpm per 100 cm² by wipe test.
3. Beta and/or gamma activity in excess of 0.2 milliroentgen per hour at the surface.

The permissible levels on glassware, tongs, lead bricks and other laboratory equipment will be the same as those for working surfaces; however, it is expected that, in certain instances in which such equipment is to be used over again in radiological operations, the presence of such equipment is permissible as long as it is appropriately labeled and stored separately from uncontaminated equipment. The glassware is to be labeled contaminated and is not to be removed from the laboratory.

Section IX, part b--- General Safety Rules

Extreme personal cleanliness and careful techniques are the primary means of preventing contamination and protecting against ingestion of loose radioactive materials. For additional information refer to the NRC at <http://www.nrc.gov/what-we-do/radiation/about-radiation.html>. To minimize contamination and prevent entrance of radioactivity into the body, the following rules must be observed in radioisotope laboratories where unsealed sources of radioactive materials are present or in use:

1. Eating, drinking, smoking, use of cosmetics, food preparation, or the storage of such items will not be permitted in laboratories where radioactive material is used or stored.
2. The storage of human food items to be used in an experimental procedure and not intended

for human consumption is permitted in a restricted area containing radioactive material only if the item is removed from its original container and placed in another suitable container which is properly labeled with regard to its nature and intended use, including the following: **EXPERIMENTAL FOOD ITEM - NOT FOR HUMAN CONSUMPTION.**

3. Oral pipetting of radioactive materials is strictly prohibited.
4. Any work, which can expose radioactive material to atmospheric distribution, shall be done in a suitable containment device. Specifically, complete containment is required when working with tritium in excess of 100 millicuries and for all loose alpha emitters.
5. Personnel are not permitted to work with radioactive material if there are open cuts, wounds or abrasions on the body.
6. When working with organic solvents, care must be taken to avoid skin contact with radioactive materials. Solvents may make the skin more permeable.
7. Appropriate protective clothing and/or devices shall be used for all manipulations of unsealed sources. Surgical glove techniques are to be used when putting on and removing gloves to avoid contaminating the inside surfaces of the gloves or the skin of the user. While wearing gloves, no contact should be made with notebooks, telephones, door knobs, water faucets, etc., to prevent spreading of contamination.
8. Tools and equipment that may be contaminated should be placed in non-porous metal trays or pans lined with absorbent disposable paper. Trays, pans, and paper should be monitored frequently and appropriate disposal or decontamination performed when contamination is significant.
9. The declared and labeled radioactive material use area will remain free of unnecessary tools, equipment or other clutter to prevent contamination and to minimize the generation of waste.
10. Radioactive materials use areas must be locked when unattended unless all radioactive materials are otherwise secured.
11. Any operation with amounts or radioactive materials which can cause a radiation hazard if the operation does not proceed according to plan shall be preceded by a sufficient number of rehearsals without radioactive material to ensure that the operation will be free of incidents.

Section IX, part c--- Emergency Procedures

Emergencies resulting from accidents in radioisotope use locations may range from minor spills of radioactive materials, involving relatively little personal hazard, to very serious situations which can affect people other than those working with the materials. Traumatic injuries may be associated with the incidents. Because of many complicating factors that may arise in any given accident involving radioactive material, procedures for handling emergencies involving radiation cannot be developed for all possible situations. **Each PI should develop and communicate to workers in their lab, procedures unique to the specific laboratory. In addition, the following general procedures should be followed in the event of a spill of radioactive material. IN ANY ACCIDENT INVOLVING PERSONAL INJURY, THE FIRST CONSIDERATION SHOULD BE FOR THE INJURED PARTY, NOT THE SPREAD OF CONTAMINATION.** Always provide life-saving first aid and then attempt to minimize and contain the spill as quickly as possible while minimizing exposure.

Minor Spills

A minor spill is one involving the loss of less than 250 uCi of radioactive material, wet or dry, from its intended container but within the physical boundaries of an approved use location. The immediate actions for handling a minor spill are as follows:

1. Notify all persons in the area that a minor spill has occurred. If you must leave the area to contact people, monitor yourself before leaving the area to be certain that you have not contaminated yourself or your clothing. Leave behind any contaminated footwear. If hands are contaminated, wash them gently with paper towels and water, leaving all towels within the spill area or radioactive waste storage container.
2. Request the assistance of another person who is qualified to work with radioactive materials (one person should supervise the cleanup to assure that accidental spread or self-contamination does not occur; that is, one should clean and the other should monitor).
3. Liquid spills:
 - a. Put on protective gloves.
 - b. Cover the spill area with absorbent material and/or contain the spill in another appropriate way.
4. Solid spills:
 - a. Put on protective gloves.
 - b. Dampen the area of the spilled material with an appropriate wetting agent, taking care not to spread contamination or create an airborne hazard.
5. Clean up the spill.
 - a. Using protective gloves and/or tongs, place the contaminated absorbent material into a plastic bag. Dispose of the bag in a radioactive waste container.
 - c. Clean the contaminated surfaces with soap and water on paper towels, using washing motions that do not spread the radioactive materials beyond the initially contaminated area. Place towels in the waste containers.
 - d. Survey the area to determine the effectiveness of the cleaning (survey instruments and/or wipe tests). Several washings may be required to reduce the contamination to near background level. If the surface cannot be sufficiently cleaned (due to absorption of liquids, etc.), the surface should be sealed and shielded until radioactive decay renders the area decontaminated (for long-lived isotopes, the surface materials may have to be physically removed for disposal).
 - e. Repeat the personal monitoring (clothing, skin).
 - f. Discard contaminated protective clothing. Decontaminate your skin if necessary. Wash carefully, but gently, with mild soap to remove contamination while avoiding the creation of skin abrasions. Pat the skin; do not rub. Water at body temperature is best as it neither opens nor closes pores.
 - g. Notify the RSO of the incident as soon as possible.

Major Spills

A major spill is one involving the loss of 250 uCi or more of radioactive material from its intended container within the boundaries of an approved use location **or** the release of **any** amount of

radioactive material outside the boundaries of an approved use location.

The immediate actions required in the event of a major spill are as follows:

1. Clear the area: notify all persons in the area not already involved in the spill to evacuate the room or area. In the event of a spill of radioactive material that is likely to create an airborne hazard, notify the building manager to arrange immediate evacuation of the entire building.
2. Prevent the spread: Cover the spill with absorbent material. Do not attempt to clean up the spill. Confine the movement of all personnel who are potentially contaminated. If the spill can create an airborne hazard, switch off any fans to minimize air dispersal.
3. Shield the source: If possible, place shielding to isolate the spilled material, but only if it can be done without further spread of contamination and without significantly increasing your radiation exposure.
4. Discard footwear and protective clothing if they are known to be contaminated or likely to have been contaminated. Wash hands and discard towels.
5. Close the room and secure the area: Leave the room and lock the door to prevent entry until emergency personnel arrive. If the spill occurs outside an approved use location, withdraw to a safe distance from the spill and maintain watch over the spill area, warning all passersby to stand clear.
6. Call for help: Notify the RSO as soon as possible (426-3906); also notify the Risk Management Office (426-3636) and Public Safety (426-6911).

APPENDIX I

Dose Limits and ALARA

External Dose Terms and Annual Limits (Adult Occupational)

Deep Dose Equivalent (DDE) - Whole body dose from penetrating radiation. Penetration depth, 1 cm (1000mg/cm²). Limit is 5 rem/year.

Lens Dose Equivalent (LDE) - Dose to the lens of the eye from penetrating radiation. Penetration depth, 0.3 cm (300 mg/cm²). Limit is 15 rem/year.

Shallow Dose Equivalent, Whole Body (SDE/wb) - Dose to the skin of the whole body from non-penetrating radiation. Penetration depth, 0.007 cm (7 mg/cm²). Limit is 50 rem/year.

Shallow Dose Equivalent, Max Extremity (SDE/me) - Dose to the maximally exposed extremity. Limit is 50 rem/year.

Internal Dose Terms and Annual Limits (Adult Occupational)

Annual limit on intake (ALI) means the derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year. ALI is the smallest value of intake of a given radionuclide in a year by the reference man that would result in a committed effective dose equivalent of 5 rem (0.05 Sv) or a committed dose equivalent of 50 rem (0.5 Sv) to any individual organ or tissue. (ALI values for intake by ingestion and by inhalation of selected radionuclides are given in Table 1, Columns 1 and 2, Appendix B of 10CFR20.1001-20.2401, which is included as Appendix B in this document).

Derived air concentration (DAC) means the concentration of a given radionuclide in air, which if breathed by the reference man for a working year of 2,000 hours under conditions of light work (inhalation rate, 1.2 cubic meters of air per hour), results in an intake of one ALI. DAC values are given in Table 1, Column 3, Appendix B of 10CFR20.1001-20.2401.

Class (or lung class or inhalation class) means a classification scheme for inhaled material according to its rate of clearance from the pulmonary region of the lung. Materials are classified as D, W or Y, which applies to a range of clearance half-times: for Class D (Days) of less than 10 days, for Class W (Weeks) from 10 to 100 days, and for class Y (Years) of greater than 100 days.

Weighting factor (WT) - for an organ or tissue (T) is the proportion of the risk of stochastic effects resulting from radiation of that organ or tissue to the total risk of stochastic effects when the whole body is irradiated uniformly. For calculating the effective dose equivalent, the values of WT are:

Organ Dose Weighting Factors

<u>Organ or Tissue</u>	<u>Wt</u>
Gonads	0.25
Breast	0.15
Red bone marrow	0.12
Lung	0.12
Thyroid	0.03
Bone surfaces	0.03
Remainder	0.30 ¹
<u>Whole body</u>	<u>1.00²</u>

1. 0.30 results from 0.06 for each of 5 remainder organs (excluding skin and lens of the eye) that receive the highest doses.
2. For the purpose of weighting the external whole body dose (for adding it to the internal dose), a single weighting factor, WT=1.0, has been specified. The use of other weighting factors for external exposure will be approved on a case-by-case basis until such time as specific guidance is issued.

Committed Dose Equivalent (CDE(MO)) means the dose equivalent to organs or tissues of reference (T) that will be received from an intake of radioactive material by an individual during the 50-year period following the intake.

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

Total Effective Dose Equivalent (TEDE) means the sum of the deep-dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures). TEDE=DDE+CEDE. The limit (stochastic) is 5 rem/year.

Total Organ Dose Equivalent (TODE) is the sum of the committed dose equivalent (of the maximally exposed organ) plus the deep dose equivalent. TODE=CDE+DDE. The limit (non-stochastic) is 50 rem/year.

Annual Dose Limits (Embryo/Fetus-Occupationally Exposed Female) TEDE 0.5 rem

Annual Dose Limits (Minor Occupational)

DDE 0.5 rem

LDE 1.5 rem

SDE(WB) 5.0 rem

SDE(ME) 5.0 rem

CDE 5.0 rem

CEDE 0.5 rem

TODE=CDE+DDE 5 rem

TEDE=DDE+CEDE 0.5 rem

Monitoring Requirements (Adult Occupational)

External

DDE@0.5 rem

LDE@1.5 rem

SDE(WB)@5.0 rem

SDE(ME)@5.0 rem

Internal

CDE@0.1 ALI(n) 5.0 rem

CEDE@0.1 ALI(s) 0.5 rem

ALARA - Acronym for: As low as reasonably achievable.

(Making every reasonable effort to maintain exposures to radiation as far below the dose limits as is practical consistent with the purpose for which the licensed activity is undertaken, taking into account the state of technology, the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to utilization of nuclear energy and licensed materials in the public interest)

APPENDIX II

Concentrations in Air and Water Above Natural Background (10 CFR20)

Please refer to <http://www.nrc.gov/reading-rm/doc-collections/cfr/part020/part020-appb.html>.

