BOISE STATE UNIVERSITY

RADIOACTIVE MATERIALS MANAGEMENT MANUAL

December, 1997

Pertaining to NRC Materials License #11-27388-01

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PREFACE

Boise State University maintains a radioactive materials management program to ensure that the use of ionizing radiation for research at the University does not result in unnecessary exposure of individuals and to comply with applicable federal regulations and the Radioactive Materials License issued to BSU by the Nuclear Regulatory Commission. The program is managed by the BSU Radiation Safety Committee, which is chaired by the Radiation Safety Officer (Campus Environmental Health Compliance Officer). The Committee is charged with the responsibility for establishing and applying proper radiation use and safety procedures. This Radioactive Materials Management Manual is issued by the Committee as a guide to University faculty, staff, students and the public regarding compliance with radiation safety requirements.

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

Section 1

General Administrative Procedures

1. At the Boise State University campus there shall be a Radiation Safety Committee (RSC), composed of the Radiation Safety Officer (RSO) and all principal investigators (PIs) specifically named in the NRC Materials License as authorized to use radioactive materials (see personnel list, Appendix D).
2. The Radiation Safety Program will be carried out by the RSC with appropriate oversight and assistance by the RSO, who will act as chair of the RSC.
3. The Campus Environmental Health Compliance Officer will serve as the RSO.
4. This Radioactive Materials Management Manual shall be made available to every principal investigator, who will be responsible for assuring that all persons under his/her direction who uses radioactive materials is knowledgeable regarding its contents.
5. 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 be subject to adherence to the procedures and requirements described in this Manual as well as applicable federal and state regulations.
6. No radioactive material may be brought onto or removed from the BSU campus without the express permission of the RSO.
7. In case of a radiation emergency, the RSO may take immediate steps to limit the exposure of individuals or the release of radiation in any facility of the University. The RSC shall be notified as soon as practicable of the emergency action.

Section 2

Radiation Safety Committee

1. 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.
2. The RSC must approve any modifications to the Radioactive Materials Management Manual.
3. The RSC shall make recommendations to the appropriate department head 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.
4. Meetings of the RSC may be called for by any member upon due notice to the chairman. Meetings require the presence of at least 2/3 of the RSC members. All decisions shall be by majority vote of those members actually present.

Section 3

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 BSU campus and ensuring the lowest practicable 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. Maintenance of an inventory record system for all sources of ionizing radiation present on, entering or leaving the BSU campus.
    e. Maintenance of a personnel exposure record for certain persons using sources of ionizing radiation.
    f. Maintenance of equipment for carrying out external radiation monitoring for all sources.

g. 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 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.

h. Maintenance of radioactive waste disposal records in compliance with regulations.

Section 4

Principal Investigators

The principal investigators (PI), 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 federal regulations.
3. Development of protocols/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 practicable.
5. Determining potential radiation doses and actual doses to personnel.
6. Posting any required signs and labels on radioisotope containers, storage locations and areas of use.
7. Conducting surveys of facilities to determine levels of contamination.
8. Proper storage and disposal of radioactive wastes.
9. Maintenance of records of radioactive materials procurement, use, surveys and personnel exposure.
10. Providing information to personnel regarding radiation exposure.

Section 5

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 9:

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 or by the PI.
7. **Pregnant women are responsible for informing their PI 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 sections identified by the PI as applicable and all relevant rules pertaining to a specific laboratory.

Section 6

Student Training

Students 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 3929) to make an appointment to view the videotapes.
2. View the videotapes at the RSO office.
3. Complete and pass a short 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.

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 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 7

Procurement and Inventory of Radioactive Materials

Principal investigators (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 BSU 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 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 BSU **" Radioactive Material Record"**, a triplicate form which may be obtained from the Radiation Safety Officer.
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 is authorized by the License and the proposed purchase amount, when aggregated with other BSU inventory, 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 BSU requisition process, but not until a control number has been issued.**

Control Numbers will be assigned sequentially according to the following codes:

Isotope	Numerical Series
P-32	P10000
S-35	S20000
C-14	C30000
H-3	T40000
Hg-203	H50000
Am-241	A60000
I-125	I70000

Receiving Radioactive Materials

Packages of radioactive materials will be delivered to BSU Central Receiving; however, as established by the License, Central Receiving will not deliver such packages to Departments. Rather, the following procedure shall be followed.

1. Central Receiving shall notify the person (PI) who ordered the material of the receipt of a package.
2. The PI shall pick up the package at Central Receiving.
3. The PI 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).
4. The PI will 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/cm^2 (or 10^{-5} uCi/cm^2), the package shall be stored and the RSO immediately notified for determination as to the disposition of the package (return to the transporter/supplier or disposal as waste).
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 radioactive material container shall be clearly labeled with the appropriate control number.

Record of Use of Radioactive Materials

1. Any aliquots of the material taken from the vial/container 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/disposed, 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 PI.

Section 8

Labeling, Shielding and Monitoring

Signs and Labeling

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
Hg-203	100 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 to1/4-inch lucite (beta) and appropriate thickness of lead sheet or blocks (gamma).

Monitoring and Surveys

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 that 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 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/cm^2; 22 dpm per 100 cm^2 by wipe test.
2. Removable beta or gamma activity in excess of 10^{-6} uCi/cm^2; 220 dpm per 100 cm^2 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 9

General Safety Rules for Laboratories

Extreme personal cleanliness and careful techniques are the primary means of preventing contamination and protecting against ingestion of loose radioactive materials. 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. Pipetting of radioactive materials by mouth 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 reasonably free of incidents.

Section 10

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 which may arise in any given accident involving radioactive material, procedures for handling emergencies involving radiation cannot be developed for all possible situations. **Specific procedures should be developed by each PI to take into account circumstances unique to the specific laboratory**. **However, 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 which 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.

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 which 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 (3999); also notify the Risk Management Office and the Campus Police.

Section 11

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 PI 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 also must be segregated according to physical form (dry solid, liquid, gas, animal) and chemical form (i.e., aqueous and 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 which 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 PI must complete a BSU **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 which are readily soluble or dispersible in water (and deminimis amounts of short-lived isotopes, such as rinsates), may be diluted and discharged to

the public sewer at sinks within the research laboratories. While the NRC License states that the amount of water discharged to the sewer from BSU facilities during any given day is sufficient to sufficiently dilute any radioactive wastes expected to be released, it is prudent to dilute the wastes **before** discharge to the sewer as prescribed by NRC regulations (these are maximum monthly averages, but should be applied to any instantaneous batch discharge):

Isotope	Dilute to:
C-14	3×10^{-4} uCi/ml
H-3	1×10^{-2} uCi/ml
Hg-203	7×10^{-5} uCi/ml

(For dilution requirements for other isotopes, see Table 3, Appendix B)

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

APPENDIX A

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/cm^2). 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/cm^2). 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/cm^2). 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

Organ or Tissue	Wt
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]
Whole body	1.00[2]

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 (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

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

Annual Dose Limits (Member of the Public) TEDE 0.1 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 B

APPENDIX C

APPENDIX D

Personnel

Radiation Safety Officer: Dr. Susan Shadle

Campus Environmental Health Compliance Officer: Cal Gillis
Campus Phone 3999, Home Phone 939-1547

Licensed Users of Radioactive Materials (and members of Radiation Safety Committee):

Licensee	Dept., Phone #,	Licensed to Use:
Al Dufty	Biology (3263)	2, 3, 4, 5, 6, 7
Cheryl Jorcyk	Biology (4287)	2, 3, 4, 5, 6, 7
James Long	Biology (1256)	2, 3, 4, 5, 6, 7
James Munger	Biology (3560)	2, 3, 4, 5, 6, 7
Robert Rychert	Biology (3495)	2, 3, 4, 5, 6, 7
Robert Ellis	Chemistry (3478)	2, 3, 4, 5, 6, 7
Susan Shadle	Chemistry (3153)	2, 3, 4, 5, 6, 7
Robert Luke	Physics (3659)	1
Richard Reimann	Physics (3691)	1
Frank Lamelas	Physics (1633)	1

Isotopes and Licensed Amounts (BSU aggregate):

1.	Americium-241 (sealed sources)		10 microcuries
2.	Carbon-14 (any, except sealed sources)		3 millicuries
3.	Hydrogen-3	"	3 millicuries
4.	Iodine-125	"	1 millicurie
5.	Mercury-203	"	100 microcuries
6.	Phosphorus-32	"	3 millicuries
7.	Sulfur-35	"	3 millicuries