

**RADIATION SAFETY MANUAL**

California State University, San Marcos



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# I. ORGANIZATION AND RESPONSIBILITIES

The purpose of the radiation safety program is to ensure that work with radioactive materials and radiation producing machines are conducted in such a manner as to protect health and minimize danger to life and property. Fulfillment of this purpose should be consistent with the educational and research goals of the University.

The purpose of the *CSUSM Radiation Safety Manual* is to set forth the policy, organization, operating procedures and standards of conduct in the radiation safety program, and to guide individuals using or having responsibility for the use of ionizing radiation in complying with University policy, conditions stipulated in the University's license, applicable regulations of governmental agencies, and national radiation protection standards. The *Code of Federal Regulations, 10 CFR 20*, and the *California Code of Regulations, Title 17*, are incorporated by this reference as part of the *CSUSM Radiation Safety Manual*.

Each Principal Investigator (PI) who is authorized to use radioactive material will be assigned a copy of the *CSUSM Radiation Safety Manual.* This shall be kept in the main facility where radioactive materials are used.

All persons using radioactive materials are required to be familiar with and comply with all provisions of this publication. Periodic revisions shall be incorporated by replacing original pages of this manual. Such revisions will be routinely issued to each official manual holder.

## A. PRESIDENT

University policy states that the President is responsible for the existence of a radiation safety program which provides for surveillance of departmental activities and radiological safety services to ensure that all sources of ionizing radiation are handled in accordance with the official policies and procedures of the University and governmental agency requirements. The President is also responsible for the interpretation of University policies and the development of additional campus policies and procedures compatible with governmental regulations, licenses and national radiation protection standards.

## B. RADIATION SAFETY OFFICER

The Radiation Safety Officer (RSO) is responsible to see that all matters related to radiation safety are appropriate to ensure an adequate safety program. The RSO has the authority to immediately stop any operation involving the use of ionizing or non-ionizing radiation, which is determined to present a significant hazard to the health and safety of the worker or the general population.

## C. RADIATION SAFETY COMMITTEE

The Radiation Safety Committee has been delegated the responsibility to set policy for the use of radioactive materials and to oversee the radiation safety program. The committee consists of those individuals listed on the license as authorized users. They are members of the faculty and staff, who will advise and assist the RSO in maintaining a safe working environment and maintaining radiation exposure at ALARA levels.

## D. THE PRINCIPAL INVESTIGATOR

The Principal Investigator (PI) is personally responsible for compliance with the regulations governing the use of radioactive materials and/or radiation producing machines. These regulations and policies are established by the USNRC, Title 17 of the California Code of Regulations, and the CSUSM Radiation Safety Committee. Specific responsibilities include, but are not limited to:

1. Plan adequately for experiments and determine the type and quantity of ionzing radiation or radioactive material to be used. This determination will generally be a good indication of the safety measures that should be employed.

1. Ensuring that only work authorized by the license and the Radioisotope Use Authorization (RUA) is carried out.
2. Ensuring that operations involving radioisotopes and radiation producing machines are performed only by personnel who have been properly instructed and authorized for such work.
3. Ensuring that adequate instruction has been given to all personnel under his/her supervision in the proper procedures for control of ionizing/non-ionizing radiation hazards. Also, to ensure that radiation exposures are reduced to levels as low as reasonably achievable (ALARA).
4. Maintaining records to document:
5. An accurate inventory showing all radioisotopes in possession.
6. Monitoring of the laboratory and other workplaces as required by the RUA.
7. Calibration of survey instruments as required by the Radiation Safety procedure.
8. Any transfers of isotopes.
9. Making records available for inspection by the RSO and authorized regulatory agencies.
10. Notifying personnel under his/her supervision of radiation exposure record data as provided by the RSO.
11. Posting any required hazard warning signs, labels on radioisotope containers, storage locations and use areas.
12. Provision of materials and equipment required in the RUA and enforcing the use of these items (including protective clothing, personnel dosimeters, survey instruments, etc.) by personnel involved in work under his/her supervision.
13. Conducting periodic surveys of authorized workplaces to assure compliance with RUA guidelines and general safety requirements. The maintainance of such documentation is required.
14. Assuring that radioactive waste and materials are handled in accordance with NRC and state regulations and are transferred properly to the safety office. The Principal Investigator is responsible for safe and proper storage of all radioactive materials and waste until it is removed from the laboratory by the safety office. Monitoring regular trash containers in laboratories as necessary to assure they are free from radioactive waste.
15. Notifying the RSO immediately in cases of:
16. Personnel contamination or suspected excessive radiation exposure..
17. Accidents or other unusual events that result in contamination of work area or releases of radioisotopes beyond the confines of the authorized work areas.
18. Pertinent changes in personnel rosters and work locations. See appendix D
19. Major changes in operational procedures or use of different isotopes. See appendix D.
20. If a safety device on a radiation producing machine becomes non-operational.
21. If there has been any tampering of a radioation producing machine or if there has been loss of equipment or material.
22. Instituting emergency action if the RSO is not immediately available.
23. Ensure that service personnel are not permitted to work on equipment, hoods, sinks or any other applicable area where radioactive material is used until:
24. An orientation of the area is provided
25. Personal protective equipment (PPE), if applicable, is provided
26. The area is free from contamination, or the contamination is irremovable and there is no significant exposure to personnel. The safety office must document the survey for this area.

## E. INDIVIDUAL USERS

Each person who has any contact with sources of radiation has a responsibility to:

1. Keep his/her exposure to radiation as low as reasonably achievable (ALARA) and well below the permissible exposures. See Table I under EXTERNAL RADIATION EXPOSURE LIMITATIONS.
2. Wear appropriate personnel monitoring equipment as prescribed by the safety office. These devices should be promptly returned at the end of each monitoring period, when terminating isotope use, or employment. Notify the safety office if there is a need for dosimetry during pregnancy. This can be done by declaring your pregnancy to the Radiation Safety Officer. See appendix A.

1. Survey hands, shoes, body and clothing for radioactivity and remove contamination before leaving the laboratory.
2. Utilize appropriate protective measures when working with radioactive material.
3. Wear protective clothing (gloves, lab coat, and eye protection).
4. Use appropriate shielding.
5. Use mechanical or remote handling devices, when appropriate, to reduce exposure to extremities. Never pipette hazardous materials by mouth, use pipetting devices.
6. Not smoke, eat or drink in laboratories and to not store food in refrigerators used for radioisotopes or other hazardous materials.
7. Maintain good work habits and safe laboratory techniques.
8. Frequently survey work areas for contamination. Document these surveys in accordance with section 2 (e)(i).
9. Label, segregate and secure radiation sources, equipment and waste. Radioisotopes requiring a "Radioactive Materials" label must be transported or stored in unbreakable containers.
10. Promptly comply with requests from the safety office concerning intake requirements and submissions of bioassays.
11. Contact the safety office immediately after decontamination of personnel has been initiated. Wash skin area gently with a mild soap and warm water or rinse eyes with water. Measure activity on contaminated area with the proper laboratory instrumentation. Personnel, clothing and equipment, which give radiation readings less than two times background, are not considered contaminated. After hours contact the University police at x4567 or 911 for emergencies. The police will contact the safety office for immediate assistance or consultation.

# II. LICENSING REQUIREMENTS & REGULATIONS

## A. UNIVERSITY LICENSE

The University has a Specific Radioactive Materials License issued by the California Department of Health Services, which describes authorized users, possession limits for each radioisotope and locations for use. Copies of the license are available in the safety office.

## B. AUTHORIZATION TO USE RADIOACTIVE MATERIALS

### 1. Research Authorizations

The University's license lists the isotopes, amounts, and typical procedures authorized. The RUA reiterates these items in a convenient form, lists personnel allowed to work with isotopes and precautions required in the lab. See appendix B.

a. Responsibilities

* The Principal Investigator is responsible for orientation and annual retraining of all persons working under his/her authorization. This information should be documented and retained for review by the RSO and applicable regulatory agencies. All personnel involved in the project must be familiar with safety requirements. See appendix C.
* Every new individual who will use radioisotopes must demonstrate competency in the use of radioisoptoes radioisotopes. If training is required either the PI or the RSO will assure its adequacy for the job.

b. Qualifications & Requirements

Authorization to use radioisotopes will be granted by the RSO providing at least minimum qualifications and requirements are met.

i. Requirements

* The radioisotopes, quantities, and chemical and physical forms of each of the radioisotopes to be used must be identified in the license.
* A brief description of lab procedures to be utilized must be provided in the RUA.
* The RSO will assure the adequacy of all proposed use locations with respect to:
* Storage facilities
* Hoods, and other special equipment
* Impact of radiation use on surrounding areas
* "Housekeeping"
* Radioisotope Control and Personnel Protection
* Inventory records of receipt, use, transfer and disposal
* Monitoring methods, frequency and records
* Survey instrumentation, calibration procedures and records
* Area Posting and access control
* Contamination control procedures
* Shielding and/or remote handling techniques
* Provision for controlling releases to the environment
* Personnel dosimetry

### 2. General Requirements for Workplaces

1. All laboratories are required to have access to radiation detection equipment capable of assessing ambient radiation levels and contamination levels of the radioisotopes to be used.
2. Requirements for shielding and/or remote handling devices will depend upon the external radiation levels of the specific radioisotopes and amounts to be handled.
3. Generally, a normal campus laboratory with impervious lab bench tops and floors, meeting standard chemical laboratory requirements for ventilation, emergency showers, fire extinguishers, etc. will be sufficient.
4. To prevent internal deposition of radioactive materials, eating, drinking, smoking, and application of cosmetics are all prohibited wherever radioisotopes are used. This applies to any work area such as a bench, refrigerator, cold room, experimental apparatus, etc.
5. All laboratories in which unsealed radioisotope is used must be surveyed as follows:

i. Survey Frequency

It is recommended that lab surveys be performed at the end of the day's work. Mandatory user surveys are required weekly during periods of isotope use. During prolonged periods of no use, no surveys are required of the work area if all isotopes are secured and the period of no use is documented.

ii. Method

The entire laboratory *shall* be checked with a meter and randomly checked with smears, which are then counted for removable contamination. Surveys *shall* include both smears and meter readings unless only C-14 and H-3 are used, in which case only smears are indicated. Liquid scintillation counting is recommended for counting smears. Areas to be checked include workstations, cabinets, floors, doorknobs, light switches, desks, regular trash receptacles, and lab personnel.

iii. Records

All mandatory surveys *shall* be documented. Records *shall* include the following:

* Date.
* Location of survey.
* Instrument used.
* Radiation/Contamination levels.
* Name of person performing survey.
* Corrective action.

Records must be maintained in the laboratory and available for inspection. See appendix F as an example.

##### C. AUTHORIZATION TO USE RADIATION PRODUCING MACHINES

1. Procedures for Purchase, Use, & Transfer
2. A department or a PI wishing to procure a radiation producing machine must obtain prior approval from the RSO before the acquisition or fabrication of a machine is carried out. The RSO needs to be notified with the following:
3. Description of machine (type of machine, manufacturer, model, year of manufacture, maximum operating parameters, energy and beam current).
4. Operating protocol and typical operating parameters.
5. Engineering controls such as shielding, interlocks, and access control.
6. Once the machine is obtained, any modification in use, design or location of a radiation producing machine must be approved by SR&S or if sold, traded, transferred or discarded.
7. Personnel Dosimetry

 Only after the appropriate training on operating procedures and safety protocols have been covered, will dosimetry be provided. All personnel that has been issued dosimetryl must wear their personal dosimeters while working with or near the machine when it is producing ionizing radiation. The PI responsible for the machine must ensure that the appropriate dosimeters are worn and returned to SR&S for assessment. Personnel dosimeters must not be used to measure beam output nor deliberately placed in the beam.

1. Safety Devices
2. Specific safety devices are required by state and federal agencies for each radiation producing machine. Example of controls are, warning lights, beam enclosures, interlocks, shielding and radiation survey meters. All safety devices shall be maintained in good working order, and must not be replaced, or modified without the RSO approval. No safety device is absolutely fail-safe or foolproof . If a safety device becomes non-operational, the radiation producing machine shall not be operated. The RSO must be notified immediately. The unit will remain non-operational until the device is repaired and inspected by the RSO.
3. A safety device must never be purposely defeated. If the design of a device makes a certain desired operation inconvenient or impossible, another device providing the same degree of protection must be substituted and approved by the RSO. Serious injuries can occur when safety devices are bypassed.
4. Posting & Labeling

Posting and labeling of radiation producing machines shall be according to 10CFR20.1902. Rooms that are used for medical diagnosis should have a warning light that indicates X-Ray On to alert personnel who may inadvertently enter a room during operation of the machine. The machine operating protocol should be posted near the equipment.

1. Machine Location

A room devoted solely to the radiation producing machine is preferred. The equipment should be placed in an area that is not in the main traffic pattern of the laboratory or near other continuously occupied work areas. The machine must be situated so that scatter or stray beams will be directed toward an unoccupied area. Any change in the location of a radiation producing machine must be approved by the RSO.

1. Surveys
2. The RSO shall inspect the radiation producing machine installment, whether newly procured, relocated, modified or repaired to ensure proper operation of the unit. The RSO shall survey each machine annually. Users shall perform safety checks on the machine if required by the RUA.
3. X-Ray Diffraction/Fluorescence Units
4. Open beam x-ray diffraction units can be very hazardous because of the very high primary beam exposure rates (several 100,000 R/minute) at the x-ray tube ports. Serious damage can result to an individual's eyes and skin, even if exposed to this intense radiation level for a very short period of time. Extreme caution must be exercised in the use of x-ray diffraction equipment. The following are requirements for safe use of x-ray diffraction units:
5. The PI is responsible for ensuring that the x-ray diffraction machine is kept in good working condition, equipment meets specifications, and safety systems are functioning.
6. Personnel working or supervising the x-ray diffraction machine are responsible for notifying co-workers and the RSO of any unsafe operating conditions or machine failures.
7. Appropriate radiation shielding must be installed on each x-ray diffraction unit. These shields should be interlocked to prevent radiation exposure to personnel in the event the shield is removed or opened.
8. All beam shutter mechanisms must be interlocked to prevent operation if the shutter is not properly closed.
9. The authorized user of x-ray diffraction equipment is responsible for ensuring that all personnel operating the equipment understand the radiation exposure potential and are properly trained in operating procedures required for radiation protection. The SR&S office will provide general radiation safety training and the PI shall provide training for the machines operations and laboratory procedures. This training shall be documented and operating procedures approved by the RSO.
10. All x-ray diffraction units and use areas must be labeled with appropriate radiation caution signs, along with the required operational radiation warning lights.

## D. LABORATORY SURVEILLANCE PROGRAM

All laboratories in which radioisotopes are used are surveyed by the RSO quarterly. This program consists of routine audits with a logical series of follow-up corrective actions.

1. Evaluation

Each audit is reviewed by the RSO. The review takes current and past safety issues and violations into consideration. Full documentation of each audit is maintained in the RSO files.

2. Follow-Up

When serious health physics concerns arise in a lab audit, a follow-up audit will be required.

3. Annual Review

Within one year of the issuance of a RUA and annually thereafter a member of the RSO reviews the total program of the authorized user. This review may include:

1. An evaluation of the laboratory inspection record and work areas used.
2. A personal interview with the PI.
3. Evaluation of the scope of the program with respect to that authorized.
4. Evaluation of compliance by the authorized user with campus, governmental regulations and special requirements set forth in the RUA.
5. Review of accuracy and completeness of records.

The RSO prepares a report of the findings and requirements, if any, for correction of deficiencies by the PI. The report is placed in the PI's file.

##

## E. SABBATICAL LEAVE

It is the responsibility of the PI to notify the RSO at least two months prior to taking a sabbatical leave or any other extended absence.

## F. USE OF RADIOACTIVE MATERIALS AT OFF‑CAMPUS LOCATIONS

At least sixty days advance notice to the RSO is necessary in order to obtain authorization from the appropriate authorities (either State or Federal) to use radioactive materials at off‑campus locations.

# III. MEANS OF CONTROLLING RADIATION EXPOSURE (ALARA Program)

## A. Basic Handling Requirements

 Every person who uses radioactive materials or radiation producing machines is responsible for handling materials in such a manner as to assure that personnel radiation exposures are as low as reasonably achievable (ALARA). Each RUA will prescribe additional specific precautions and conditions.

## B. Basic Radiation Safety Principles and Work Rules

 Radiation sources can be divided into two groups when discussing physical principles for preventing or minimizing exposure to ionizing radiation. These groups contain those sources, which are external to the body, and those sources, which are internally deposited within the body.

### 1. Control of External Exposure

The distance from the source, the exposure time, and shielding controls external radiation exposure from a given radioactive source.

Increasing the distance from the source is frequently the most effective and economical means to reduce radiation exposure from gamma rays and other highly penetrating radiations. The radiation field varies inversely with the square of the distance. For this reason, tongs or other long handled tools should always be used for manipulating radionuclide preparations emitting significant levels of radiation. Radioactive materials should never be picked up with the fingers. Low-level sources can be handled with short forceps, which provide a large reduction in exposure when compared with direct skin contact.

Decreasing the time of exposure decreases the radiation dose proportionately. It is important to include "dry runs" with non-radioactive material for critical steps in preplanning all work, which may involve substantial radiation exposure. An estimate of radiation dose is a fundamental aspect in preplanning for work with radioactive material.

Shielding the source of radiation will be necessary when the maximum distance and minimum time do not ensure a significantly low exposure to operating personnel. Interposing materials, preferably of high atomic number and high density, between the source of radiation and the area to be shielded, accomplish shielding for gamma radiation.

Beta radiation can be shielded by using a solid material such as Lucite (acrylic polymer) to absorb the radiation. Beta radiation produces a penetrating x-ray called Bremsstrahlung when it strikes material of high atomic number. The intensity of Bremsstrahlung radiation varies directly with the square of the energy of the beta radiation and the average atomic number of the shielding material. For this reason, low atomic number materials such as Lucite or glass should be used for shielding beta radiation whenever possible. When working with energetic beta emitters, care must be taken to avoid exposing hands above opened containers where the dose rate can be on the order of hundreds of rads per minute for commonly used quantities of beta emitters such as P‑32. Where radioactive material emits both beta and gamma radiations, shielding considerations will be controlled by the gamma radiation.

Appropriate shielding must be provided so that the radiation exposure rate from radioisotope sources is less than 2 mR/hr in any uncontrolled area.

### 2. Control of Internal Exposure

Distance, time and shielding are obviously not available for protection when the source of radiation is internally incorporated into the body. Preventing ingestion, inhalation or absorption of unsealed sources of radioactive material most easily controls incorporation of radioactive material into the body. All significant quantities of unsealed radioactive material must be used inside properly designed exhaust ventilated enclosures.

In a low or moderate level laboratory, protective clothing consisting of laboratory coats, eye protection, and rubber, latex or vinyl gloves should be worn when working with radioactive material.

A second reason for preventing radioactive contamination is to assure reliable experimental results, avoiding contamination of radiation measuring instruments, and cross contamination of experiments. If this technical contamination is controlled, internal exposure of laboratory personnel will usually not be a serious problem.

### 3. Laboratory Safety Rules

1. No individual is to undertake work with radioactive materials or radiation sources without prior knowledge and understanding of the possible exposure to be incurred and the means available to control this exposure. Plan ahead and try out all new procedures using nonradioactive material.
2. Eating, drinking, smoking and the application of cosmetics are forbidden in workrooms and laboratories where radioactive material is stored or used with the exception of clean areas approved by the RSO.
3. Protective gloves are required for all operations involving radioactivity in the laboratory. Laboratory coats are required when performing operations with hazardous materials. Closed toe shoes shall be worn in all laboratories where radioisotopes are used.
4. Solutions containing radioactive material shall not be pipetted by mouth.
5. A catch pan of nonbreakable material must be used under any vessel or equipment, which may leak, burst, or spill a radioactive material.
6. Students and employees should monitor themselves for contamination before leaving work areas. Portable and fixed instruments for use in radioisotope monitoring must be provided and maintained by the approved users of radioactive material. The RSO should be notified immediately about contaminated areas or personnel so that corrective action can be taken.
7. Personal effects shall not be stored in radioactive materials work areas.
8. Operations, which involve loose radioactive materials, such as radioactive dry soil, evaporation of radioactive liquids, and any process, which could lead to production of airborne activity, are to be performed in an adequately ventilated hood or glove box.
9. No radioactive materials are to be removed from posted areas and laboratories without authorization of the lab supervisor.
10. Samples being transferred from one room to another shall be carried in a container.
11. Food and beverages are not to be stored in laboratory refrigerators, freezers or cold rooms.
12. No containers or utensils normally used for food or beverages shall be used for storing or handling radioactive materials.
13. If applicable, radioactive sources shall not be manipulated with the fingers. Suitable forceps or tongs shall be used.
14. Possible contaminated hands should be carefully washed and monitored before touching the face, body or other individuals.
15. All radioisotopes must be stored in approved areas.
16. Return unused radioactive material and radiation sources to proper storage when not in use.
17. No persons under the age of 16 or pets are allowed in laboratories using radioactive material. Individuals aged 16‑18 need specific approval from the RSO prior to using radioisotopes.

## C. Labeling of Radioactive Material

All primary containers in which radioactive material is used or stored must be conspicuously labeled with an approved label showing:

1. The black or magenta radiation symbol.
2. The words, "Caution Radioactive Material".
3. Identification of the radioactive substance.
4. Amount of radioactivity.
5. The date labeled.

Radioactive materials in unlabeled containers will be subject to impounding. Secondary containers (such as individual test tubes) do not need to be labeled if they contain less than the quantity of radioactive material specified in 17 CCR Section 30356, Appendix B.

## D. Warning Signs and Signals for Restricted Areas

Restricted areas are those areas which contain any radioactive material which is ten times the quantity listed in 17 CAC Section 30356, Appendix B, or which is so designated by the RSO. In addition to the above labeling requirements, these areas will be posted with one or more of the following signs:

1. "Caution - Radioactive Material"

Areas in which radioactive material is used or stored in the amount exceeding ten times the quantities listed in 17 CAC Section 30356, Appendix B, shall be marked with a sign which displays a magenta or black radiation symbol and the words "Caution Radioactive Material".

2. "Radiation Area"

Radiation areas are those within which it is possible for an individual to receive a whole-body exposure in excess of 5 mrem in any one hour. All such areas shall be marked with a sign, which gives the radiation level and displays a magenta radiation symbol and the words "Radiation Area".

3. "High Radiation Area"

High radiation areas are those within which it is possible for an individual to receive a whole-body exposure in excess of 100 mrem in any one hour. All such areas shall be marked with a sign that gives the radiation level and displays a magenta radiation symbol and the words "High Radiation Area". Access to such areas shall be strictly controlled by the supervisor responsible and shall be on a "need-to-enter" basis.

#  IV. PROCUREMENT, TRANSFER & DISPOSAL OF RADIOACTIVE MATERIALS

## A. Procurement of Radioisotopes

All radioisotopes purchased at the University are pre-approved by the RSO as a step in the purchase order flow. The RSO assures that only isotopes authorized by the license and the users RUA are purchased and that the inventory for the University stays within the possession limits.

1. Receiving and Storage

Incoming radioisotopes shall be delivered to Shipping\Receiving and then to the Isotope Lab, where they shall be monitored and checked for leakage and/or damage. The PI will be notified when the shipment is ready to be released.

## B. Transfer of Radioactive Material

1. Between Locations on Campus

No radioactive materials may be transferred from one person or laboratory to another unless the recipient has a valid RUA for the isotopes and quantities to be transferred. All transfers must be preapproved by the RSO.

2. Transfer of Radioactive Materials Off-Campus

All transfers of radioactive material off-campus must have specific prior approval from the RSO. The RSO will obtain approval for transfer from the receiving institution's RSO, as well as, a copy of their radioactive materials license.

a. For Transfer Within the San Diego Area

1. The RSO will arrange and record any transfer within the San Diego area.
2. Radioactive material must be packaged according to DOT specifications and the means of transportation adequate to ensure safety during transfer.

b. For Transfer via a Common Carrier

1. A *Shipping Request/Shipping Memo* form must be filled out and delivered to the RSO, along with the isotope(s) to be shipped, already packed in the appropriate shipping container.
2. Radioactive material must be packaged according to DOT and/or IATA specifications for packaging and labeling.

## C. Disposal of Radioactive Material

All radioactive waste must be placed in a special container labeled "Radioactive Material," shielded adequately and stored in a suitable location. DO NOT PLACE ANY RADIOACTIVE WASTE IN THE REGULAR TRASH RECEPTACLES. The RSO shall arrange for the disposal of the radioactive waste material.

All waste must be segregated as follows:

### 1. Liquid Wastes

Liquid waste includes the radioactive solution and at least the first rinse of its container. DO NOT DISPOSE OF LIQUID RADIOACTIVE WASTES VIA A SINK DRAIN OR OTHER SEWER OPENING.

1. The only suitable containers for liquid radioactive waste are nalgene carboys or other plastic containers. Any other container must be specifically approved by the RSO. Contact the RSO for supply information
2. Carboys must be capped at all times and kept in a secondary container capable of holding the entire contents of the carboy (e.g. dishpan).
3. Carboys are for liquid only - absolutely no solid matter is allowed (e.g. no pipettes, plastic pipette tips, microcentrifuge tubes, electrophoresis gels or organic matter).
4. DO NOT OVERFILL CARBOYS. Leave at least 4 inches of space at the top.
5. If necessary store liquid waste behind appropriate shielding to reduce the radiation level to less than 2 mR/hr.
6. Measure the radiation level at the surface of any liquid waste container. Notify the RSO prior to pick-up if radiation emitted is greater than 5 mR/hr.
7. If you plan to use electrophoresis gels, contact the RSO for a suitable container.
8. Special collection techniques are used for disposal of stock solutions or high specific activity liquid wastes. Contact the RSO for specific instructions.
9. Carboys must be labeled, stating the PI's name, building and room, isotope(s) and activity, and the chemical form (e.g., aqueous, organic etc.).

###

### 2. Dry Waste

Dry waste is paper, gloves, empty vials, disposable glassware, microcentrifuge tubes and other contaminated material. Lead pigs, sheets, foils, etc. qualify as mixed waste and as such are **not** to be included in dry waste.

Note: Empty means no liquid or liquid-containing mixture such as LSC gel and no observable movement of liquid when shaken. Dry waste must not include any free or contained liquid.

a. Collection

Specially marked containers should be used to collect dry radioactive waste. Cardboard boxes for this purpose labeled *Radioactive Waste* are available for purchase. Radioactive waste containers should be easily distinguished from non-radioactive waste containers.

b. Packaging and Storage

1. Place in double plastic bags (clear, ~1.25 ml) and seal with non-perforated tape.
2. If appropriate, store dry waste behind shielding to reduce the radiation level to less than 2 mR/hr.

c. Mixed Biological and Radioactive Waste

1. When possible, any combined radioactive and pathogenic waste should be inactivated at the source. Use appropriate *cold* sterilization techniques for the pathogen involved. If *cold* sterilization is not possible, contact the RSO for specific instructions.

d. Sharp Objects

1. The term "sharps" includes needles, pipettes, pipette tips, burettes, broken glass or any object, which has the ability to penetrate a plastic bag. This even includes large pipettes.
2. Collect "sharps" in a *hard walled*, *leak-proof* container. Plastic "sharps" boxes are appropriate. These containers must not contain free or contained liquids (such as full syringes).

## D. Inventory of Radioisotopes

The *California Radiation Control Regulations* require that a complete and accurate inventory be maintained of all radioactive material. The RSO maintains an inventory by recording all incoming shipments of radioisotopes and all outgoing waste shipments. This inventory is updated quarterly.

In addition, each PI should maintain an inventory of his/her own stock of radioisotopes. A record must be maintained of each stock solution. Records shall be kept in the lab and made available for inspection. See appendix E.

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# V. DOSIMETRY

It is possible for a given individual to receive radiation doses from both internally deposited radionuclides and sources external to the body. In this event, both internal and external exposures need to be considered in evaluating the status of that individual.

## A. EXTERNAL RADIATION DOSIMETRY

### 1. Types of Radiation Dosimeters

Two types of dosimeters are used to monitor exposure to personnel while using radioactive materials.

1. Badges are used to monitor whole body exposures - either beta-gamma/x-ray or neutron plus beta-gamma/x-ray.
2. Thermoluminescent (TLD) badges and ring dosimeters are also used for monitoring exposures.

### 2. Issuing Dosimeters

The RSO will issue the appropriate type of dosimeter for the conditions to be encountered. Whole Body Badge dosimeters are issued to personnel who work with more than 1 millicurie of P-32. If any one experiment uses more than 1 mCi of P-32 at a time Finger Ring dosimeters will also be issued. Other beta emitters: C-14, S-35 or Ca-45 do not require dosimetry. Note: A badge or dosimeter should be processed immediately whenever serious exposure is suspected. Call the RSO if such an occasion arises.

###

### 3. Exchange of Dosimeters

It is the individual user's responsibility to exchange his or her dosimeter(s) upon request of the RSO. It is vital that exchange of dosimeters be made promptly in order to keep exposure records accurate and current. In addition to routine exchanges, dosimeters may also be exchanged at the request of an individual or his/her supervisor.

### 4. Proper Use of Dosimeters

1. Only the person who is assigned a dosimeter shall wear it. Do not loan a badge or use it for monitoring an area. Badges for the latter purpose are available upon request.
2. Ring dosimeters shall be worn when there is a possibility of significant exposure to the hand (> 1 mCi P-32 per experiment). It is important to wear ring dosimeters on the finger that is nearest the radiation source. Usually, the index finger receives the greatest exposure. The dosimeter should be worn under gloves to protect it from contamination.
3. Wear badges whenever working with or around radiation sources at any CSUSM facility or location. If you are concurrently working with radiation at another institution, it is their responsibility to provide you with their own dosimeter. It is your responsibility to advise the RSO if you are working with radiation at another institution. Do not wear badges when undergoing personal medical or dental diagnosis or therapy, since occupational dose limits are not applicable in these instances.
4. Use care when removing aprons and lab coats so that badges are not left in exposure areas, such as near radioactive materials. If a badge is exposed in this manner, the badge should be changed immediately since the additional dose should not be ascribed to the wearer. Return the film to the RSO with an explanatory note.
5. The dosimeter must be promptly returned for processing. Delay in returning your badge results in extra work and correspondence for follow-up. A badge, which is returned late, cannot be processed with the control badge supplied with the shipment.

### 5. How to Obtain Dosimeters

The RSO will arrange for dosimetry to be issued. The following information concerning each wearer is required for proper documentation.

a. Full name of wearer.

b. Social Security Number.

c. Birth date.

d. Campus Department or Laboratory Affiliations.

### 6. Obtaining Records of Exposure

Badge results, including current, quarterly, yearly and lifetime doses are available from the RSO's files. A copy of the monthly dosimetry report is sent to each PI for posting in his/her own area.

## B. EXTERNAL RADIATION EXPOSURE LIMITATIONS

No one shall knowingly expose himself or others to levels of radiation greater than those given below, except in cases of extreme emergency.

These exposure limits do not apply to medical and dental diagnosis or therapy.

TABLE I

MAXIMUM PERMISSIBLE DOSES

|  |  |
| --- | --- |
| **Occupational Exposures** | **Annual Limit (rem)** |
| Whole body | 5 |
| Extremities or skin | 50 |
| Lens of the eye | 15 |
| Persons under 18 years of age | 10% of above |
| Embryo/fetus | 0.5 during gestation |

1. Over-Exposure

Report any actual or suspected over-exposure of radiation to the RSO immediately. Depending upon circumstances, the RSO will take all necessary actions such as a written investigation, a note in the individuals badge record, or referral to a physician. The physician shall be instructed to inform the RSO whenever an individual is diagnosed as having a radiation exposure related injury or disease, or whenever any individual claims the existence of such an injury or disease.

### 2. Exposure to Pregnant Personnel

Current U.S. Nuclear Regulatory Commission recommendations state that during the entire gestation period, the maximum permissible dose equivalent to the embryo-fetus from occupational exposure of the expectant mother should be 0.5 rem. The University embraces these guidelines. (Refer to Appendix A.)

## C. INVESTIGATIONS OF OVEREXPOSURE

The University administrative guideline is 100 mrem per month whole body exposure for radiation workers. The RSO investigates all exposures exceeding these guidelines. When indicated, bioassays will be performed. The record of these investigations will be added to the radiation exposure file of the individual, and the individual and his supervisor will be informed of the results.

The RSO is responsible for notification to the State of California, Department of Health Services in cases of known or suspected exposure above the legally permitted dose limits. Whenever these dose limits have been reached or exceeded, depending upon the extent of the overexposure, personnel may be required to avoid future work with radiation for a period of time.

## D. DOSIMETRY RECORDS

The RSO maintains complete and accurate personnel dosimetry records for review by the State and for transmittal to authorized agencies outside the University. Copies of monthly dosimetry reports are sent to each PI for his/her group. An individual can obtain his own exposure record by request to the RSO. In cases of exposures, which require notification to the State of California, Department of Health Services, a report will be provided to the individual involved. The law requires that dosimetry records of non-CSUSM exposures be obtained and retained on file. Each individual who has previously used radioactive material will be requested to sign a *Radiation Exposure History* form to release this information.

## E. SUBCONTRACTORS, VISITORS, AND GUESTS

Employees who are responsible for the presence of either outside contractor employees, visitors, or guests in any radiation laboratory shall, in conference with the RSO, decide whether and what personnel dosimetry is necessary.

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# VI. EMERGENCY PROCEDURES, SPILLS AND INCIDENTS OF RADIOACTIVE CONTAMINATION

The following general plan is to be used whenever radioactive materials have escaped from their normal hoods, enclosures, or transport/storage containers:

* EVACUATE ALL PERSONNEL TO A SAFE DISTANCE in order to limit the chance of spreading any further contamination.
* Immediately notify the RSO and give the pertinent facts concerning the incident. After hours, contact University Police.
* Quarantine the contaminated areas so that there will be no risk of further exposure of personnel to penetrating radiation or airborne radioactivity.
* Retain involved persons in a safe area until the PI or the RSO monitors them for contamination.

|  |  |
| --- | --- |
| **FOR EMERGENCY ASSISTANCE, CALL:** | **TELEPHONE NUMBER:** |
| Safety, Risk & SustainabilityRadiation Safety Officer | 750-4502 |
| After Hours:University Police | 750-4567 or 911 |
| After hours:University Police Dispatch | 750-4567 or 911 |

## A. SERIOUS INJURY INVOLVING ACTUAL OR SUSPECTED EXPOSURE TO RADIATION

1. Provide emergency care immediately for serious injuries and preserve vital functions.
2. Contact CSUSM police for transportation to a hospital.
3. Notify the RSO.
4. If possible, monitor the injured and remove contaminated clothing and gross decontamination.

## B. CONTAMINATION OF PERSONNEL

### 1. Skin or External Contamination

External or surface contamination should be treated by washing with mild soap and copious amounts of water. Avoid organic solvents or abrasive soaps, which make the skin more permeable to the contaminating substances. For contaminated hands, give special attention to areas between the fingers and around the fingernails. Repeat no more than three or four times if radioactivity persists. Don disposable gloves on contaminated hands and continue wearing them until the RSO is contacted.

### 2. Contaminated Wounds

When the skin is lacerated by glassware or injured by hypodermic needles or other instruments containing radioactive materials, immediately wash the wounded area thoroughly under a stream of cold water. Notify the RSO immediately.

### 3. Ingestion of Radioactive Material

Accidental ingestion or swallowing of radioactive material should be treated like other types of poisoning. Notify the RSO immediately.

## C. MANAGEMENT OF RADIATION INCIDENTS AND EMERGENCIES

The following rules are guidelines only and should be interpreted in relation to the incident. Even with the best techniques, accidental releases of radioactivity (liquids, vapors, dusts) can happen. Results will range from trivial to serious, depending on preparation to cope with an incident. Often the best preparation is to analyze the situation before acting.

### 1. Radioactive Spills

Decontamination shall be carried out by the group responsible for causing the spill, under the supervision of the RSO. Protective clothing (gloves, lab coat, shoe covers, etc.) shall be worn during decontamination.

1. Confine the spill immediately.
2. If the spill is liquid, drop absorbent paper on the entire area.
3. If the spill is a dry material, use caution to prevent material from becoming airborne and place dampened absorbent material (paper or towels) over the contaminated area.
4. Decontaminate and use a radiation detection meter to check progress of the work. Work inward from the outer edge of the spill. Place contaminated material in plastic bags.
5. Monitor everyone involved in the spill and clean up. Discard all material used in the clean-up procedure as radioactive waste.
6. Restrict access to the area until a wipe test survey indicates there is no residual activity remaining. If contamination remains after diligent efforts have been made, quarantine the area of concern and notify the RSO.
7. At the request of the RSO, the person responsible for the spill shall submit a report of the incident. The RSO will evaluate the incident and consult with the Radiation Safety Committee where deemed necessary. If applicable, the State of California, Department of Health Services will be notified according to 17 CCR, Title 30295 and 30297.

# APPENDIX A. PREGNANT PERSONNEL POLICY

During the gestation period, the maximum permissible dose equivalent to the fetus from occupational exposure of the expectant mother should not exceed 500 mrem. This policy is in keeping with the recommendations of the Nuclear Regulatory Commission (NRC). The following plan is recommended to departments and services where ionizing radiation sources are used:

1. Each principal investigator is responsible for advising all employees, students and personnel working under his/her authorization of this policy. All personnel must be familiar with the contents of the Appendix to Regulatory Guide 8.13. "Possible Health Risks to Children of Women Who Are Exposed to Radiation During Pregnancy", which is reproduced in this manual.
2. Individuals are responsible for disclosing to their supervisor or principal investigator as soon as possible of their pregnancy (either fact or suspicion), so that appropriate appraisal of their potential radiation exposure may be made. The RSO is available for consultation and advice to personnel and their supervisors.
3. The individual's workload and schedule will be reviewed to reduce or avoid procedures where the potential exists for radiation exposure.
4. The film badge should be worn at waist level and will record the skin dose of the mother. (The exposure of the fetus will be less than the mother’s skin dose by a factor that varies with the energy of the radiation, inverse square law, etc.).
5. Badges will be processed monthly. If the integrated readings of the badge at the waist level are greater than 50 mrems during any one month, the workload again requires critical review. If the integrated readings total 300 mrems within six months or less, the pregnant worker should consider transfer or leave. When the calculated exposure to the fetus totals 500 mrems, transfer or leave is mandatory and the individual shall not use radioactive materials until completion of the gestation period.

# APPENDIX B. RADIATION USER AUTHORIZATION

California State University San Marcos

Radioisotope Use Authorization (RUA)

Principal Investigator:  RUA Number:

Office: Exp. Date: 1/10/09

**-Project Description-**

Radioactive materials may be used to perform biomedical research and for instructional purposes only.

**-List of Authorized Isotopes-**

|  |  |  |  |
| --- | --- | --- | --- |
| **ISOTOPE** | **FORM** | **mCi / exp** | **TOTAL mCi** |
|  | Any |  |  |
|  | Any  |  |  |
|  | Any |  |  |

**\*\***Total mCi is the amount of radioactive material, which you can have in your lab(s) at any one time, inclusive of waste.

**-Radioactive Material may only be used or stored in the following locations-**

# **>>**

**-Only the following individuals are authorized to work with radioactive materials-**

|  |  |
| --- | --- |
| **NAME** | **TRAINING DATE** |
|  |  |
|  |  |
|  |  |

**-Responsibilities for Compliance-**

The Principal Investigator is personally responsible for compliance with the University and government regulations as they pertain to his/her authorized use of radioactive materials. Specific responsibilities include but are not limited to:

1. Ensuring that only work authorized by the license and the Radioisotope Use Authorization (RUA) is performed.
2. Ensuring that only personnel who have been properly instructed and authorized for such work perform operations involving ionizing materials and machines.
3. Ensuring that adequate instruction has been given to all personnel under his/her supervision in the proper procedures for control of ionizing radiation hazards and assuring that ionizing radiation exposures are reduced to levels as low as reasonably achievable (ALARA).
4. Maintaining records to document:
	1. An accurate inventory showing all radioisotopes in possession.
	2. Monitoring of laboratory and other workplaces as required by the RUA.
	3. Calibration of survey instruments as required by the Radiation Safety Manual.
	4. Any transfer of isotopes.
5. Records must remain available for inspection by the RSO and inspecting government agencies.
6. Notifying personnel under his/her supervision of ionizing radiation exposure record data as provided by the RSO.
7. Posting all required hazard warning signs, labels on radioactive material storage containers, storage locations and use areas.
8. Provision of materials and equipment required in the RUA and enforcing the use of these items (inclusive of protective clothing, personnel dosimeters and survey instruments) by personnel involved in work under his/her supervision.
9. Conducting periodic surveys of authorized workplaces to assure compliance with RUA guidelines. Maintaining documentation of such surveys as required.
10. Assuring that radioactive waste is disposed of properly. Monitoring regular trash containers in laboratories as necessary to assure they are free from radioactive waste.
11. Notifying the RSO immediately in cases of personnel contamination or suspected excessive radiation exposure, accidents or other unusual events that result in contamination of work areas or releases of radioactive material beyond the confines of the authorized work areas.
12. Instituting emergency action if the RSO is not immediately available.
13. Notifying the RSO promptly of changes in personnel, location and/or procedures.

Deviations from this authorization or policies and procedures established in the Radiation Safety Manual may result n the prohibition to use radioactive materials.

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 Radiation Safety Officer Date

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 Principal Investigator Date