



# **Radiation Safety Manual**

**2006**

CSUS Radiation Safety Manual

INDEX

2006 Revision

1.1 President's Policy.....3  
1.2 Purpose of Radiation Safety.....4  
1.3 Scope of the Manual.....4  
1.4 Organization.....4  
1.5 Responsibilities.....5  
  
2.1 Licensing and Registration.....8  
  
3.1 Faculty Users.....8  
3.2 Radiation Worker.....8  
3.3 Statement of Training and Experience.....8  
3.4 Application for Use.....9  
3.5 Approval Process.....9  
3.6 Renewals.....9  
3.7 Termination.....9  
3.8 Amendments.....9  
  
4.1 Procurement.....10  
4.2 Leak Testing and Delivery.....10  
4.2a Opening Packages.....10  
4.2b Surveys.....11  
4.2c Removable Contamination Action Levels...12  
4.3 Storage.....13  
4.4 Signage.....13  
4.5 Limits of Exposure.....14  
4.6 Personnel Monitoring.....16  
4.7 Safety Rules for Laboratories.....17  
4.8 Lab Monitoring Procedures.....18  
4.9 Inventories.....20  
4.10 Waste Disposal.....21  
4.11 Training.....24  
  
5.0 Radiation Producing Machines.....24  
5.4 Security.....25  
5.5 Emergency Procedures.....25  
5.6 Spill Response.....26

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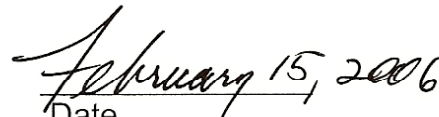
## Radiation Safety Manual

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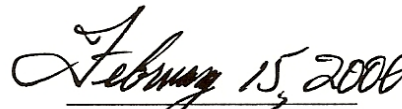
It is the policy of the University that the requirements of the Radiation Safety Manual be met by all faculty, staff and students utilizing radiation in order to keep doses and exposure as low as reasonably achievable. Strict adherence to the Radiation Safety Manual is essential to reduce risk, minimize exposure, maintain security and comply with state and federal regulations regarding radioactive materials and radiation producing machines. No radioactive materials or ionizing producing machines may be utilized without meeting the requirements of the radiation safety manual.

Compliance and oversight of radiation safety is the responsibility of the Radiation Safety Committee and the Radiation Safety Officer.

  
Thomas R. Custer, RSO

  
Date

  
Stephen Garcia,  
Vice President for Administration

  
Date

# **Radiation Safety Manual**

## **Section 1 Introduction**

### **1.1 The President's Policy**

The President of California State University, Sacramento directs that all radioactive materials and equipment capable of producing ionizing radiation shall be handled in accordance with the provisions of the Radiation Safety Manual which presents campus policy, standards and procedures for compliance with the regulations of the applicable governmental agencies.

### **1.2 Purpose of the Radiation Safety Program**

The primary purpose of the Radiation Safety Program is to insure that work with radioactive materials and equipment capable of producing ionizing radiation is conducted in such a manner as to protect the health and safety of individuals subject to exposure to radiation from such sources. A further purpose is to aid in the instruction of faculty, students and staff in proper radiation safety procedures. The goal of the radiation safety program is to keep the radiation exposures to personnel as low as reasonably achievable.

### **1.3 Scope of the Manual**

Status and regulations of the State of California pertaining to the licensing and use of ionizing radiation are expressly incorporated as part of this Manual. Copies of the state regulations are available for review from the Radiation Safety Officer (RSO). This manual applies to all radioactive materials and radiation generating machines requiring licensing or registration in accordance with Title 17, California Code of Regulations

### **1.4 Organization**

The Radiation Safety Committee (RSC) members are appointed by the President to provide advice on all matters relating to the use of ionizing radiation and radionuclides and to be responsible for maintaining oversight of implementation of the requirements of radioactive materials license and Radiation Safety Manual. Membership includes the RSO, the Director or designee of the Student Health Center, Two instructors from departments using radionuclides or radiation generating equipment, one staff member from the College of Natural Science and Mathematics, one Dean or Associate Dean from a School using radionuclides or radiation generating equipment. The RSC will hold regular meetings at least quarterly. A quorum shall consist of a

simple majority of the membership and must include the RSO or his/her designated alternate. Copies of the minutes shall be forwarded to the appropriate deans and the Vice Presidents.

### **1.5 Responsibilities**

#### *A. Radiation Safety Committee*

1. Approves all proposed changes, deletions, amendments and addition to the radioactive materials license issued by the State of California, Department of Health Services (DHS), Radiologic Health Branch, before these amendments are submitted to this agency.
2. Reviews the results of quarterly radiation surveys, surveys of radiation producing machines and leak-testing of sealed sources.
3. Reviews existing Radiation Use Authorization (RUAs) and Machine Use Authorization (MUAs) annually, reviews new or amended RUAs and MUAs before approval.
4. Analyzes alternative solutions to potential or existing problems and provides the majority vote for the recommended action by the RSC Chair or RSO appropriate.
5. Evaluate such other items pertaining to radiation safety as it deems appropriate.

#### *B. Chair, Radiation Safety Committee*

The RSC chair shall be elected for two year term and ensures that the RSC meets at least quarterly and that the committee minutes are distributed to appropriate Deans and Vice Presidents. The Chair acts administratively on the behalf of the Committee on all matters pertaining to radiation safety. The Chair advises the President on Committee membership.

#### *C. Radiation Safety Officer*

1. The RSO is the direct representative of the President in working with all University users to assure understanding and compliance with appropriate radiation safety regulations and practices.
2. Provides the Committee counsel and advice on regulatory changes, developments and interpretations.
3. Maintains all records mandated by the Radiologic Health Branch and is named on the CSUS Radioactive Materials License.
4. Arranges for equipment calibration, dosimetry services and disposal of radiation waste.
5. Reports any reviews, changes or amendments to RUAs and MUAs at least to the committee and reports any action taken

on RUAs and MUAs that were required between Committee meetings.

6. Reviews all dosimetry reports, reviews all proposed purchases of radioactive materials and radiation generating machines and provides written documentation of approvals to the Committee.

7. Coordinates designation and acceptance of new facilities including storage areas of the radioactive materials.

8. Reviews all requests for relocations of existing radiation machines or radioactive materials storage.

9. Investigates accidents and provides emergency responses to incidents

10. Evaluates proposed uses of radioactive materials

11. Acts as liaison with the with the Radiologic Health Branch.

12. Advises Committee regarding Title 17, California Code of Regulations.

13. Coordinates inventory reporting requirements.

14. Responsible to advice department Chairpersons of any major changes in regulations or good practices which may effect the possession, use, storage or handling of radioactive materials or the use of the radiation producing devices.

15. Responsible to promptly meet with the new Department Chairpersons to provide a briefing on the salient features of CSUS Radiation Safety Program and the use of ionizing radiation in their departments.

16. Responsible to promptly bring to the attention of Department Chairpersons any unsafe acts or unsafe conditions involving the use of ionizing radiation so the Department Chairpersons may expeditiously take action to correct the situation.

#### *D. Deans*

The responsibility for the safe and prudent use of licensed radioactive materials and radiation producing machines rests with the Dean of the School in which these activities take place. As the HEERA-designated manager, the Dean is vested with the authority and responsibility to assure safe working conditions for the employees in the school and the safe learning conditions for the students in school.

Ensures that all active radiation workers complete required annual radiation safety training.

#### *E. Department Chairpersons*

1. Responsible for review and approval of proposed uses of radioactive materials and radiation producing machines within the department.
2. Responsible to provide resources for proper maintenance and safe operating conditions for all licensed radioactive materials and radiation producing machines in the department. If funds are not available, the Chairperson shall solicit such funds from the Dean's office. If proper maintenance or safe operating conditions cannot be assured, the Chairperson shall direct faculty users not to use the material or equipment and take such actions to preclude use of the material or equipment.
3. Responsible for supervising staff radiation workers.

*F. Faculty Users*

1. Responsible for the safety of their students
2. Are required to be named on the applicable RUAs and /or MUAs.
3. Must understand and implement the proper and safe use of the radionuclides and radiation producing machines in compliance with applicable regulations and University requirements.
4. Permit only activities authorized by the RUAs and/ or the MUAs.
5. Maintain dosimetry use records where applicable, ensure students and/or instructors are required to wear proper dosimetry where applicable and that all dosimetry are properly secured after use.
6. Secure radioactive materials and ensure the proper startup, use and shutdown of radiation producing machines, both in the classroom and research usages.
7. Instruct, inform and remind students of safe procedures in all matters of radiation protection.
8. Maintain safety procedures as an integral part of the instructional program.
9. Use written protocols when operating instructions and emergency procedures are required.
8. Ensure proper return and security of all radioactive sources and dosimetry at the end of laboratory/classroom sessions.
9. Ensure use of non-exempt radioactive materials is permitted only in controlled areas, fitted with special keyed locks with access only by authorized personnel. Such areas shall be conspicuously marked with appropriate warning signs.
10. Ensure that students exposure is kept as low as reasonably achievable through safety instruction, design

considerations and experimental procedures which are based on good laboratory practices.

11. Promptly inform their Department Chairperson if there is a maintenance or operating condition problem and shall not operate equipment or use materials until such condition is corrected or accommodated.

12. Maintain security of all sources, update the radionuclide inventory every six months, complete annual radiation safety training, and ensure that all co-workers listed on the RUA / MUA attend annual required training.

## **Section 2 Licensing and Registration**

### **2.1 Scope of the University License**

The University possesses the license issued by the DHS, Radiologic Health Branch. This license permits the use of all radionuclides in specified quantities according to their atomic number and mass number subject to all applicable rules, regulations and orders of Office of DHS and limitations of the license. Details concerning registrations are incorporated in this Manual in part and can be obtained from the RSO

### **2.2 Renewal and Amendment of License**

Renewal and amendment of the license is the responsibility of the RSO in conjunction with the RSC and certificating by the campus President or his/her designee. Amendment of the License will be required for the use of radioactive materials involving:

Use of radionuclides under the conditions other than those permitted in the license. Possession and use of radionuclides in amounts in excess of the limits stipulated.

2.3 Registration of the Ionizing Radiation Generating Machines All ionizing radiating generating machines shall be registered with the State of California, DHS, Radiologic Health Branch. Such registration shall be the responsibility of the RSO in conjunction with the RSC.

## **Section 3 Application for use of Radioactive Materials and Ionizing Radiation Generating Machines**

### **3.1 Faculty Users**

Department Chairs will ensure that all radiation use in their departments is done only as approved by the RUA or MUA. All users of radioactive materials or radiation generating machines must be under the supervision of a Faculty User who has been issued an RUA or MUA.

### **3.2 Radiation Worker**

Anyone who uses or handles radiation or radioactive generating materials as part of their job is a radiation worker and must be listed on a RUA or MUA.



### **3.3 Statement of Training and Experience**

All radiation workers shall file with the RSO a "Statement of Training and Experience" before working with radiation. which will be evaluated by the RSC. Students utilizing radiation in a classroom setting shall not be required to file a " Statement of Training and Experience".

### **3.4 Application for Use**

Each Faculty User shall have filed with RSO and have approved by the RSC an application for "Use of Radioactive Materials or Radiation Generating Machines" for their particular use.

3.5 Approval Process - Radiation Use Authorization (RUA) and Machine Use Authorization (MUA)

- a) Authorization shall be classified either classroom use or research use for liquid and sealed sources and machine use for radiation generating machines.
- b) Radiation use authorizations and machine use authorizations shall be issued for a calendar year and amended and cancelled by the RSC.
- c) All applications for RUAs and MUAs shall be reviewed by the RSC and when approved, issued by the RSO.
- d) Upon issuing of RUA or MUA, dosimetry shall be issued if required and a bioassay schedule established if required.

### **3.6 Renewal of Authorization**

The RSC shall annually review RUA's and MUA's and determine if there are any changes in any RUA and any MUA. If there have been no changes, then the RUA or MUA may be renewed for one year, provided that good practices are followed and the results of personnel dosimetry is as low as reasonably achievable. Changes in personnel or procedures require a re-submittal and review / approval of the RUA / MUA to the Radiation Safety Committee

### **3.7 Termination of Use Authorization**

If the RSC determines that the user is violating the University, State or federal regulations, authorization for use will be revoked or suspended by the RSC, until proper use is reinitiated and assured.

### **3.8 Amendment of the RUA or MUA**

Any changes on the original authorization, as approved by the RSC and on file with the RSO, shall require an amendment to the RUA or MUA The following can be approved by the RSO only:

1. On-campus storage or use location changes.
2. Personnel changes in users or radiation workers.

3. Changes in physical or chemical form of radionuclides. The following changes must be approved by a quorum of the RSC:

1. Off campus location use (requiring an amendment of the campus broad scope license).
2. Changes or amendments to the license.
3. Additions or changes to the use authorizations.
4. Increase in the possession or experimental limits of each radionuclide.

#### **Section 4 Procedures and regulations governing use of Radionuclides.**

##### **4.1 Procurement**

Any purchase, loan or gift of radioactive material requires the prior approval of the RSO. Purchases shall be requested on standard requisition forms indicating: The amount and identity of the radioactive material and radiation generating machine. That material is to be delivered to the RSO or another person designated by the RSO. The requisition shall be sent to the RSO who will either indicate approval by signing or forwarding it to the purchasing department or returning to the originator with an explanation of the disapproval. Telephoned orders must be cleared by this process before being transmitted to the supplier.

##### **4.2 Leak Testing and Delivery**

Upon receipt of the radioactive materials to the RSO, the material shall be verified for correct shipment, wipe tested (external and internal package) for leakage and radiation fields measured at the surface of the package and at one (1) meter from the package to confirm compliance with Department of Transportation (DOT) regulations. Packages found to exceed DOT regulations shall not be delivered to the faculty user, and vendor shall be notified of the problems. Packages meeting all the above criteria shall be delivered to the authorized locations on the RUA. Signed receipt is required.

##### **4.2a. Opening Packages Containing Radioactive Materials**

All Type A packages which are received bearing White I, Yellow II, or Yellow III labels must be monitored for surface contamination within 3 hours after receipt during normal working hours, or within 3 hours of the start of the next working day if received after normal working hours. Type A packages with evidence of damage must be monitored to determine external radiation levels. Unlabeled, exempt

packages do not require any monitoring unless the packaging is damaged.

#### Procedure

1. Wear gloves
2. Visually inspect the package for damage, notify the RSO if it is damaged.
3. Measure the dose rate at 1 meter and at the package surface, using a survey meter calibrated in mR/hr. The expected dose rate in mR/hr at 1 meter should be close to the DOT "transportation index" noted on the package. The expected maximum dose rates at the surface are:

#### DOT Transportation Index:

White I	.5	mR/hr
Yellow II	.5-50	mR/hr
Yellow III	.5-2	mR/hr

4. If the package exceeds these levels, notify the RSO, who will then notify the Radiologic Health Branch and the manufacturer.
5. Wipe test at least 300 sqcm of the exterior of the package. Notify the RSO, who will notify the manufacturer and the Radiologic Health Branch if contamination exceeds 2200 dpm for gamma radiation or 220 dpm for alpha/beta. (see "Removable Contamination Action Levels")
6. Wipe test the radioactive material and packing materials for the same levels of contamination. Notify the person who ordered the material and the manufacturer if the source is leaking higher than the above levels.
7. Monitor the source package and packing material with a survey meter, if it is not contaminated it can be disposed of in normal trash.

#### 4.2b. Surveys

Surveys are required in areas where workers could be exposed to 2.5 mR/hr.

Surveys of restricted areas must include adjacent non-restricted areas if sources are stored or used that could

generate an exposure of 2.0 mR/hr or more outside of a restricted area.

#### Unsealed Radioactive Sources

Principle Investigators will survey radiation laboratories and storage areas

Monthly if less than 200uCi are used at any one time  
Weekly if more than 200 uCi are used

The RSO will survey the above areas, plus areas where sealed radioactive sources are stored or used, quarterly.

The surveys will be conducted with a survey meter appropriate for the isotope and sufficiently sensitive to detect 0.1 mR/hr and calibrated within the last year.

Smear tests must be conducted with instrumentation appropriate for the type of emission and sufficiently sensitive to detect the limits listed under "Removable Contamination Action Levels"

#### 4.2c

#### Removable Contamination Action Levels (NRC Regulatory Guide 8.23)

Contamination on surfaces, equipment, areas, must be removed if it exceeds these limits; and shipping packages are considered contaminated, if levels are greater than ( in dpm / 100 sq cm):

	Type of Radioactive Emission		
	Alpha	Beta or X-Ray	Low-Risk Beta or X-Ray*
Unrestricted Areas:	22	220	2200
Restricted Areas:	220	2200	22000
Personal clothing:	22	220	2200
Skin	22	220	2200

- Low risk beta or xray nuclides include C14- H-3, Tc-99m and others with energies less than .2 MeV or gamma less than .1R/hr at 1 meter / Ci.

#### 4.2c Instrument Calibration

Survey Instruments must be calibrated annually.

GM and ION chamber survey instruments will be calibrated by outside organizations authorized by their license to perform calibrations. This is currently being done by the Health Physics Department at UC Davis Medical Center.

The Victoreen neutron meter is being calibrated by Lawrence Livermore Berkely Labs.

#### 4.3 Storage

Storage of radioactive materials shall be secured to prevent unauthorized removal and shall be provided with reasonable protection against loss, leakage or dispersion by the effects of fire or fire suppression activities. Only approved locations on the respective RUA or MUA are authorized as storage locations. **Radioactive materials may not be stored or used in a manner that could expose the general public outside of a radiation controlled area to 2mR (.02Sv) in any one hour.**

#### 4.4 Warning Signs

a) Rooms in which radioactive materials are used and stored shall be posted: "Caution-Radioactive Material" on a sign bearing the radiation symbol. Radioactive materials shall not be transferred to or used in an unposted area.

b) Areas in which there exists a radiation level such that an individual could receive any one (1) hour a dose to the whole body in excess of 5 millirems, or in any five (5) consecutive days a dose in excess of (100) millirems shall have a sign conspicuously posted bearing the radiation symbols and words "Caution -- Radiation Area". Any area in which an individual could receive a whole body dose in excess of 100 millirems in one (1) hour shall be posted with similar sign using the words: " Caution-- High Radiation Area".

c) Any area in which radioactivity is dispersed in the air in the form of dust, fumes, mists, vapors or gases in excess of those allowed by regulation (CCR, T17, 30355) shall be posted similarly using the words: "Caution -- Airborne Radioactivity."

d) Containers holding radioactive materials for storage or during processing and use shall be clearly labeled with a sign bearing the radiation symbol and the words:

"Caution -- Radioactive Material" and shall state the quantities, identity of the isotopes and the date it was placed in the container.

e) Posting of rooms with the above warning signs which are known not to contain radionuclides or radiation sources is prohibited.

f) "Notice to Employees," State of California form RH2364, shall be posted permanently and conspicuously in all areas where work with radiation is carried out.

g) Gas chromatograph units containing titanium tritide shall be posted with a sign: "Warning -- Do Not Operate above 225 Degree Centigrade." Gas chromatograph units containing scandium tritide shall be posted with a sign: "Warning -- Do Not Operate Above 325 Degree Centigrade."

#### 4.5 Limits of Exposure to Ionizing Radiation

From 10 CFR § 20.1201 Occupational dose limits for adults.

(a) The licensee shall control the occupational dose to individual adults, except for planned special exposures under § 20.1206, to the following dose limits.

(1) An annual limit, which is the more limiting of--

(i) The total effective dose equivalent being equal to 5 rems (0.05 Sv); or

(ii) The sum of the deep-dose equivalent and the committed dose equivalent to any individual organ or tissue other than the lens of the eye being equal to 50 rems (0.5 Sv).

(2) The annual limits to the lens of the eye, to the skin of the whole body, and to the skin of the extremities, which are:

(i) A lens dose equivalent of 15 rems (0.15 Sv), and

(ii) A shallow-dose equivalent of 50 rem (0.5 Sv) to the skin of the whole body or to the skin of any extremity.

(b) Doses received in excess of the annual limits, including doses received during accidents, emergencies, and planned special exposures, must be subtracted from the limits for planned special exposures that the individual may receive during the current year (see § 20.1206(e)(1)) and during the individual's lifetime (see § 20.1206(e)(2)).

(c) The assigned deep-dose equivalent must be for the part of the body receiving the highest exposure. The assigned shallow-dose equivalent must be the dose averaged over the contiguous 10 square centimeters of skin receiving the highest exposure. The deep-dose equivalent, lens-dose equivalent, and shallow-dose equivalent may be assessed from surveys or other radiation measurements for the purpose of demonstrating compliance with the occupational dose limits, if the individual monitoring device was not in the region of highest potential exposure, or the results of individual monitoring are unavailable.

(d) Derived air concentration (DAC) and annual limit on intake (ALI) values are presented in table 1 of appendix B to part 20 and may be used to determine the individual's dose (see § 20.2106) and to demonstrate compliance with the occupational dose limits.

(e) In addition to the annual dose limits, the licensee shall limit the soluble uranium intake by an individual to 10 milligrams in a week in consideration of chemical toxicity (see footnote 3 of appendix B to part 20).

(f) The licensee shall reduce the dose that an individual may be allowed to receive in the current year by the amount of occupational dose received while employed by any other person (see § 20.2104(e)).

[56 FR 23396, May 21, 1991, as amended at 60 FR 20185, Apr. 25, 1995; 63 FR 39482, July 23, 1998; 67 FR 16304, Apr. 5, 2002]

a) No individual shall be occupationally exposed to radioactive material by ingestion or inhalation in excess of the occupational values specified in 10 CFR 20.1001-20.2402, Appendix B, Table 1.

d) In no case will an individual under the age of eighteen (18) years be permitted to receive an occupational dose in excess of 10% of the limits set forth in a. above or exposed to more than 10% of the values specified in b. above.

e) No user shall possess sources of radiation in such a manner as to create in any area of radiation levels which would cause an individual member of the public to receive a dose to the whole body in excess of:

2 millirems (0.02 Sv) in any one (1) hour or  
0.1 rem(1 mSv) in any one (1) year

f) No user shall release or cause to be released into the  
air or water in any unrestricted  
area any concentration of radioactive material which when  
averaged over any one

(1) year, exceeds the limits specified in 10 CFR 20.1001-  
20.2402, Appendix B,  
Table 2.

#### 4.6 Personnel Monitoring Program

a) The responsibility for compliance with the personnel  
monitoring regulations rest on the Faculty User. It is an  
important part of the obligations assumed when approval  
for use of radioactive material or radiation generating  
machines is granted by the University.

b) Personnel monitoring devices will be required for any  
person eighteen (18) years of age or older working with  
radioactive materials or ionizing radiation generating  
machines whenever entering a controlled area under  
conditions where he/she is likely to receive in any  
calendar quarter a dose in excess of 10% dose listed in 4.5  
a.

or, if under eighteen (18) years of age, the dose listed in  
4.5 b.

c) Personnel monitoring devices will be distributed through  
EH&S. Film badges will normally be the type of personnel  
monitor required. Ring badges are required for  
individuals working where it is likely the hand exposure  
may exceed the dosage listed in 4.6 b. Pocket dosimeters  
may be utilized in lieu of film badges for  
individuals entering controlled areas on an infrequent or  
temporary basis.

d) Film badges, when required, are to be worn at all times  
when the individual is occupationally exposed. They should  
be worn in a fashion so as to indicate whole  
body exposure (breast pocket, belt etc.), except in the  
case of finger rings. The badge is not to be worn when the  
individual is undergoing diagnostic or therapeutic  
radiation exposure.

e) Film badge exposure records will be maintained by EH&S;  
when required in writing by an individual, EH&S will  
provide a copy of his/her permanent occupational exposure.  
Records of exposure will be forwarded to new employers upon  
request for the individual.



f) In cases of inhalation or ingestion of radioactive materials may have occurred, the RSO/RSC may require urine or blood samples from the individual for analysis. Other types of bioassay may be pursued as deemed appropriate. In addition, in an emergency situation or unusual event when it is suspected that an uptake may have occurred, a bioassay will be performed with 24-48 hours.

g) Bioassay for Iodine 125 or Iodine 131 shall be performed on individuals involved in operations with those materials in a non-contained form as follows:

Any radioactive compound which through a chemical or physical process becomes volatile (i.e., sodium iodide, Bolton-Hunter Regent) and the amount used at one (1) time is greater than 1mCi, personnel should be required to perform a thyroid bioassay within 24-72 hours after use.

h) Bioassay for tritium uptake shall be performed on individuals involved in operations with that materials in a non-contained form as follows:

Any tritium compound which through a chemical or physical process becomes volatile (i.e., water sodium borohydride) and the amount used at one time exceeds: (1) 10mCi - open bench; (2) 100mCi - fume hood, personnel shall be required to submit a urine sample for analysis within twenty four (24) hours after use.

#### 4.7 Operational Safety Rules for Laboratories

##### a) General Safety Rules for Unsealed Material

The Faculty User is responsible for insuring that every employee, instructor and student under his/her jurisdiction who may be exposed to ionizing radiation is fully instructed in the necessary precautions specific to their operations and protection of themselves and others in prevention of radioactive contamination and radiation exposure. It is the responsibility of the faculty user to use the smallest quantity of radioactivity sufficient to produce the necessary results. Eating, drinking, smoking and the application of cosmetics in the laboratory is prohibited. The work area shall be small be as small as possible and clearly labeled. New techniques should be tested on a "dry run" to verify they are designed to prevent accidents and accidental contamination.

##### b) Handling of Unsealed Materials

Personnel cleanliness and careful techniques are the primary means for the prevention of contamination and protection against internal intake of radioactivity. In order to minimize contamination and to prevent entrance radioactivity. In order to minimize contamination

and to prevent entrance of activity into the body, the following rules shall be observed in radioisotope laboratories where unsealed sources are used:

1. The pipetting of radioactive solutions by mouth is prohibited. Remote pipetting devices are available and mandatory for such applications.
2. Protective clothing/or devices shall be used for all manipulations with unsealed sources where where the possibility of contamination exists. In particular disposable gloves and lab coats shall be worn whenever contamination is possible. Surgical gloves should be used for putting on and removing gloves in order to avoid contamination. Eye protection should be worn whenever aerosol contamination or splashing could occur.
3. Work which may result in contamination of the work area shall be done over trays of nonporous material lined with plastic-backed absorbent paper. Any work with materials susceptible to work with atmospheric distribution (i.e., by vaporizing, spilling, dusting, effervescence of solution or other releases of radioactive gas) should be done in a suitable hood or glove box with minimum face velocity of 100 LFM.
4. Thorough monitoring of hand, feet and clothing is mandatory whenever leaving a radionuclide laboratory where work with unsealed radioactive materials is in progress. Each individual radionuclide user is personally responsible for monitoring his/herself for contamination every time they leave the radionuclide area. Articles which show contamination shall be left in the work area or other area designated for this purpose. Any contamination on the skin shall be removed by washing with soap immediately or reported to RSO. Contaminated equipment or equipment that has been used and is suspected of contamination, shall be labeled, contained and isolated in designated areas in the laboratory or in a suitable storage space.

#### **4.8 Laboratory Monitoring Procedures**

##### **Contamination Survey Frequency**

**Faculty User:** Personnel should survey for contamination in locations where individuals are working with an unsealed form of radioactive material in an amount greater than or equal to 10% of the smallest "ANNUAL LIMIT ON INTAKE" (ALI) (either the inhalation or ingestion ALI) listed for that Radionuclides in 10 CFR Part 20. These surveys should be done at a frequency appropriate to the types and quantities

of radioactive materials in use, but at a minimum quarterly. If amounts are used that are greater than or equal to the smallest ALI listed for that Radionuclides in 10 CFR Part 20, detailed, documented surveys should be performed at least monthly.

**Contamination Survey Frequency**

	<b>&lt;0.1 ALI</b>	<b>0.1 - 1.0 ALI</b>	<b>&gt;1.0</b>
<b>ALI</b>			
<b>Areas in Use</b>	<b>Monthly</b>	<b>Weekly</b>	<b>Daily</b>
<b>Areas Not in Use</b>	<b>Every 6 months</b>		

a) EH&S shall conduct surveys of all areas in which unsealed and sealed radiation is utilized and recommended/require corrective measures where contaminated surfaces have been detected or inadequate shielding is being used.

b) It is the responsibility of the Faculty User to monitor laboratory procedures and operations with a survey meter and wipe tests (for unsealed radiation use), to make appropriate corrective measures when needed and to maintain a minimum monthly records of the monitoring results if use has occurred.

c) Each survey instrument used in these procedures must be calibrated annually.

d) Each non-exempt sealed source other than Hydrogen-3 or Krypton-85 in gaseous form, and source material, shall be tested by EH&S for contamination prior to initial use and for leakage each six (6) months. If there is reason to suspect that a source might have been damaged, it must be tested for leakage before further use. If the test reveals the presence of 0.005 microcurie or more of removable contamination by a standard wipe test, it shall be withdrawn from use and repaired and disposed.

4.9 Inventory of Radioactive materials  
 A central inventory of radioactive materials on campus is maintained by EH&S. Each Faculty User must keep records of the amount and kinds of unsealed radioactivity under

his/her supervision so that the central inventory may be updated biannually.

#### 4.10 Radioactive Waste Disposal

##### a) Introduction

Low level waste permits must be obtained from appropriate facilities licensed by the NRC. Radioactive waste may only be picked up and transported by companies licensed to do so by the Department of Health Services, Radiologic Health Branch.

All radioactive waste and unwanted radiation sources must be disposed of in accordance with the applicable regulations and procedures. Radioactive waste management is very important part of the radiation safety program and radioactive waste are tightly controlled from generation to disposal by regulations, waste disposal facilities, transporters, and waste brokers. The waste generator is responsible for the waste it generates indefinitely even after the waste burial. Radioactive waste management must be handled with great care by a trained and qualified person who is fully aware of the responsibilities. All the required information in the waste log must be recorded.

##### b) Responsibilities of Radioactive Waste Generators

The Authorized User must label waste containers as to their content and keep a record of the waste he/she generates (reasonable estimates of the activity are acceptable). Waste should be surveyed prior to discarding into the radioactive waste container to confirm if it is radioactive. This survey should be completed using a proper survey meter such as Geiger Mueller (GM) counter, ionization chamber, etc. Almost all isotopes except H-3 can be detected by a thin window GM counter. If the waste is non-radioactive then it should be placed in ordinary trash.

DO NOT COMBINE RADIOACTIVE MATERIALS AND HAZARDOUS CHEMICALS. Radioactive materials may not be disposed of via the sanitary waste system. Incineration of radioactive waste is prohibited. Radioactive labels or signs or tapes must not be placed in radioactive waste container. Radioactive waste shall be segregated by half-life. Short half-life isotopes (< 90 day half-life) such as P-32, S-35 and I-125 require individual waste containers. Long half-life isotopes (> 90 day half-life) such as H-3 and C-14 may be combined in the same container as long as their activities are listed separately.

When waste containers are full, perform radiation surveys and wipe the outside surface for loose contamination. If contamination is found, decontaminate the areas of

contamination. All waste containers must have radioactive material warning labels. The following information must be recorded on the log sheet provided with each container:  
Name of Authorized User.

Identify Isotope.

Amount of isotope in millicuries or microcurie.

Date material is placed in container.

Identify any presence of any other hazardous materials.

Note: Do not seal the container. The container must be inspected by RSO and staff.

#### **c) Personnel Protection Methods**

Based on the information provided by the authorized user, the following personnel protection methods will be selected to prevent contamination and internal exposures to radiation.

At a minimum, the personnel protective equipment that shall be used during the handling of radioactive waste containers includes disposable gloves, lab coat and a film badge to measure exposure.

Radioactive waste that contains an organic solvent may require the use of chemical resistant gloves during handling. Radioactive waste that has a tendency to become airborne should be handled in a certified and approved laboratory fume hood and/or with a respirator fitted with a high efficiency particulate air filter. Radioactive materials having the potential to release airborne alpha particles should be handled in the laboratory hood or with a respirator.

#### **d) Waste Packaging Procedures**

Packaging of radioactive waste for shipment from the campus is normally done by the RSO and/or staff. Dry solid waste must not have standing liquid or moisture which may condense. All waste must not have hazardous constituents. The RSO and/or staff will provide collection, packaging, and shipping of the radioactive waste.

#### **Types of Wastes**

Radioactive wastes are generated at California State University Sacramento are categorized as either a dry, solid waste, liquid scintillation waste or liquid waste. A dry radioactive waste includes dry solid materials, contaminated papers, glassware, gloves or apparel. A liquid scintillation waste consists of the radioactive material and a liquid solvent generated from using the scintillation counter. A liquid radioactive waste includes liquid radioactive materials, solutions, and contaminated rinse.

A liquid radioactive waste is further categorized as aqueous and non-aqueous. Aqueous wastes are those which are readily soluble in water. A non-aqueous waste is a liquid, which is not readily soluble in water and should not include any organic solution which can be segregated from the aqueous waste stream. These liquids include such scintillation

fluids as toluene and xylene. Radioactive waste shall be segregated by half-life. Short half-life isotopes such as P-32, S-35 and I-125 (< 90 day half-life) require individual waste containers. Long half-life isotopes such as H-3 and C-14 (> 90 day half-life) may be combined in the same container as long as their activities are listed separately.

#### **Packaging of Dry Radioactive Waste**

Dry, solid radioactive waste shall be placed in a special container (box) received from the RSO or staff. The container will come with two plastic liners that will be used to contain the radioactive material. Each liner will have a thickness of 4 mils. No labels are to be put into the container such as radioactive labels, biohazard labels, or any type of warning label. No syringes or other sharp objects are to be placed directly into the waste container that could puncture the plastic liner. The objects must be placed in an approved secondary container prior to disposal. In addition, no liquids are allowed in the dry waste container. Place the radioactive waste into one liner and then wrap the other liner over the initial liner. Place the wrapped radioactive material into the box. All waste containers must be identified with the radiation symbol, the words "CAUTION-RADIOACTIVE MATERIAL" and a completed log sheet. The box will be taped shut by the RSO or staff and transported to a designated storage location. Perform a radiation survey and/or collect a wipe sample to detect any contamination on the outside surface of the box. Record results.

#### **Packaging of Liquid Scintillation Vials**

Hazardous chemicals, as defined by US EPA, are not to be mixed with radioactive materials. Biodegradable, non-hazardous liquid scintillation solutions should be used. Short half-life isotopes such as P-32, S-35 and I-125 (< 90 day half-life) require individual waste containers. Long half-life isotopes such as H-3 and C-14 (> 90 day half-life) may be combined in the same container as long as their activities are listed separately. All vials must be collected in a scintillation waste bucket containing a 4

mil plastic liner or if a bucket is not used, the vials may be packed in the original shipping box.

The vials are not to be opened and should be checked for loose caps prior to being deposited in the waste container. Do not dispose of non-radioactive vials in the waste barrel. All waste containers must be identified with the radiation symbol, the words "CAUTION-RADIOACTIVE MATERIAL" and a completed log sheet. The container will be taped shut by the RSO or staff and transported to a designated storage location. Perform a radiation survey and/or collect a wipe sample to detect any contamination on the outside surface of the container. Record results.

#### **Packaging of Liquid Waste**

Liquid radioactive waste should be retained only in proper receptacles that may be provided by the RSO and staff. The container will typically be placed in a plastic bottle, which is stored inside a second container. Isotopes should be segregated in the same manner as dry waste.

Do not place vials, glassware, or solid waste into the container. Hazardous chemicals defined by US EPA are not allowed to be mixed with radioactive materials.

Radioactive solvents which are organic and not readily dispersible in water (e.g. ether, xylene, toluene, hexane) need to be segregated in separate containers. To prevent a release of the solvent, the radioactive solvent should be placed in a compatible container. All waste containers must be identified with the radiation symbol, the words "CAUTION-RADIOACTIVE MATERIAL" and a completed log sheet. The container will be taped shut by the RSO or staff and transported to a designated storage location.

..Perform a radiation survey and/or collect a wipe sample to detect any contamination on the outside surface of the container. Record results.

#### **Transportation of Radioactive Waste**

Transportation of the radioactive material is governed by Code of Federal Regulations, Title 49 (CFR 49), Sections 100-179. Most of the transportation requirements for radioactive materials are concentrated in CFR 49, Sections 172-173. CSUS will contract with a radioactive waste contractor to meet these requirements during the shipment of a radioactive waste material from the campus to a disposal facility. The RSO is responsible for review of the manifest and providing the necessary signature.

#### **4.11 Radiation Training (amended 6/3/96)**

All employees planning to work with ionizing radiation covered by this manual shall attend a radiation protection

seminar/training session prior to such use. Attendance at the refresher training session is required at least once every two (2) years. Failure to meet the refresher training requirements after two (2) written notifications may result in loss of the privilege to use ionizing radiation at the University.

Classroom use training requirements for ionizing radiation can be met by either the instructor or the RSO or his/her designee presenting a summary of radiation safety guidelines prior to the laboratory work.

Exception to the above policy is as follows:

Temporary radiation workers (radiation work period less than or equal to one (1) month must be trained by the supervisor in good health physics practices and policies, and directly supervised in his/her work. Attendance at health physics seminar is recommended, but not mandatory. The Faculty User shall document the radiation safety training that they provide.

## **Section 5 Process and Regulations Governing The Use of Ionizing Radiation Generating Machines and Large Gamma Sources**

### **5.1 Procurement and Disposal of Ionizing Radiation Generating Machines**

a) All procurement, whether by purchase, loan or gift, requires the prior approval of the RSO. Certification of such approval is to be submitted to the purchasing department with the purchasing requisition or request for approval for a loan or gift.

b) Disposal of ionizing radiation generating machines require prior written notice to the RSO/RSC.

### **5.2 Requirements for Safety and Operating Procedures**

Operation of an ionizing radiation generating machine or large gamma source (generally capable of producing in areas accessible to individuals a radiation level of 100 millirems per hour or larger) requires the preparation and the approval of the RSC of an operational guide which includes safety and emergency procedures. The Faculty User of the machine shall be responsible for supplying each user under his/her jurisdiction with a copy of the guide and insuring that each user is instructed in the appropriate procedures.

### **5.3 Controlled Areas, Operating Signals and Signs**

a) Controlled areas associated with ionizing radiation generating machine or large gamma sources shall have access restricted and be appropriately posted.

Areas or rooms that contain permanently installed x-ray machine as the only source of radiation may be posted with



sign(s): "Caution - X-Ray" in lieu of the signs specified in 4.4 b. & c.

b) Each ionizing radiation generating machine or large gamma source capable of producing a dose rate in any accessible area to individuals in excess of 100 millirems per hour shall be provided with conspicuously visible or an audible alarm signal. Such alarm signal shall be activated automatically when radiation is being produced. Further, each entrance or access to such shall be: Equipped with a control device to reduce radiation level in that area to below 100 millirems per hour; or Equipped with control device that shall energize an alarm to alert any individuals entering the area and the supervisor of the operation; or maintained lockout except during periods when access is required, with positive control over each entry. The controls must be established in such a way that no individual will be prevented from leaving the high radiation area.

c) All devices and equipment capable of producing ionizing radiation when operated shall be appropriately labeled as to caution individuals that such devices or equipment produces ionizing radiation.

#### **5.4 Security, Posting, Labeling**

Faculty Users are responsible for ensuring that all radioactive materials must be locked and secured from theft when not in use. All vials, containers and sources of radioactivity shall be labeled with isotope, amount and date. All storage areas will be clearly labeled with "Caution Radioactive Material" placards; "No eating drinking" signs and the Department of Health Services "Notice to Employees" with directions for contacting the RSO, reporting an emergency, and the location of Title 17.

#### **Section 6. Emergency Procedures**

Emergencies resulting from accidents in isotope laboratories may range from minor spills or radioactivity involving relatively low personnel hazard, to major radiation incidents and spills involving extreme hazards and possible bodily injury. Because of numerous complicating factors which may arise, and because of the wide range and variety of hazards, set rules of emergency procedures cannot be established to cover all possible situations. In any emergency, however, the primary concern must be the protection of personnel from radiation hazards. The secondary concern is the confinement of contamination to the local area of the accident, if possible.

## **Spill Kit**

Each work area utilizing liquid radioactivity shall have a spill kit containing:

1. disposable gloves, 6 pair, large size
2. package of detergent, large size
3. steel wool pads and scouring (powder) cleaner
4. plastic-backed absorbent paper
5. disposable shoe covers
6. plastic bags
7. "Radioactive Material" tape
8. wipe tests swatches
9. roll of masking tape or duct tape
10. paper towels
11. tongs for picking up broken glass
12. waterproof, all-surface marking pen

### **a. Minor Spills - spill response and cleanup**

Notify others in the room a spill has occurred.

1. Cover the spill with absorbent paper.
2. Monitor skin and clothing for contamination. Skin should be decontaminated using copious water flushes, without abrasive scrubbing. If skin exposure occurred call the RSO.
3. Any contaminated clothing shall be removed and bagged.
4. Personnel not essential for cleanup can leave the room after being monitored. To avoid the spread of contamination, the bottom of the shoes should be monitored.
5. Pick up broken glass with tongs and bag it or place it in a suitable "sharps" container.
6. Using the spill kit and the safety gloves and disposable paper booties, decontaminate from the outside edge to the center of the spill, bagging all used cleanup process.
7. Continue decontamination until removable contamination is less than the Removable Contamination Level (RCAL see above, section 4.2b).

If no more can be removed, cover the area with the absorbent paper, labeled with "Radioactive Material" tape, secure entry

to the room and call RSO.

8. Monitor all clean up personnel for contamination.
9. date and time, exact location and who was present.

Include how much radioactivity was involved and documentation that it was cleaned up to less than "Removable Contamination Action Levels", or is consistent with background by being within the 95% confidence level of background.

### **b. Major Spills involving substantial radiation hazard to personnel :**

1. Notify all persons in the room at once, of the hazard.

2. Request all persons not involved in the spill to vacate the room AT ONCE
3. Make no immediate attempt to clean up the spill. If the spilled substance is liquid and the hands are protected, right the container.
4. If the spill is on the skin, flush thoroughly with water. If the spill is on clothing, remove and bag clothing at once.
5. Vacate the room and prohibit entrance to contaminated area.
6. Notify the RSO as soon as possible giving all details of the spill.
7. Use the radiation monitor to evaluate any residual personnel contamination.
8. Permit no person to work in the area until the approval of the RSO is secured.
9. Under no circumstances should an untrained person attempt to examine or clean up the radioactive materials.
10. If necessary, in accordance with CCR, T17 30295, the RSO will notify and make a report of the DHS.

**c) Accidents involving radioactive dusts, mists, fumes, vapors and gases:**

1. Notify all other persons to vacate the room immediately.
2. Hold your breath and switch off air circulating devices, if time permits.
3. Vacate the room
4. Notify the RSO at once.
5. Ascertain all doors giving access to the room are closed and locked. If necessary, post guards to prevent accidental opening of doors.
6. Do not reenter the room until approval of the RSO is secured.

**d) Fires involving radioactivity**

Notify all persons in the room and building at once. When persons in the room are notified, one (1) person shall be directed to call the Fire Department and the RSO immediately.

**e) Overexposure or Ingestion**

Any person who suspects overexposure to radiation from any source must report immediately to RSO. (Any exposure in excess of 1.25 rem whole body delivered in a period of thirteen [13] weeks or less is regarded as an overexposure for the purpose of these regulations.)

Any person who swallows, ingests, absorbs or otherwise ingests radioactive materials (excluding normal

environmental contaminants and excluding medical diagnostics or therapy) must undergo bioassay procedures to determine the extent of the exposure. The RSO shall make arrangements for all bio assay tests.