

# Radiation Safety Manual



California State University, Chico

The Department of Environmental Health and Safety

October 2020

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NOTE: In case of emergency, contact the Radiation Safety Officer (ext. 5126 during working hours) or University Police (911, 24 hours a day).

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# 1.0

# INTRODUCTION

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The California Department of Health Services, Radiologic Health Branch (RHB) controls the quantities and use of radioactive materials and radiation producing machines in this State. They have issued a "Broad Scope B" License to California State University, Chico, which grants the University the authority to possess specific radioisotopes, and grant the authorization to use these isotopes to qualified faculty and staff. Persons granted such authorizations are termed "Authorized Users" (AU's).

The Radiation Safety Manual has been written to inform both the RHB and University personnel of the University's policies controlling sources of ionizing radiation, and requirements regarding AU status acquisition and retention. Possession of a valid AU status is a privilege. Any single AU's actions can affect the entire License. For that reason, strict adherence to the provisions of this Manual and the AU's approved procedures is imperative.

The purpose of the Radiation Safety Program is to ensure that radioactive materials and machines capable of producing ionizing radiation are utilized in a manner that will protect health, eliminate danger to life and property, to keep exposures to radiation "As Low As Reasonably Achievable" (ALARA), and comply with relevant State and Federal regulations.

## 2.0

# RADIATION SAFETY PROGRAM

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### 2.1 Role of the University President

The RHB considers the University President ultimately responsible for the safe use of all regulated radioactive materials and radiation-producing machines on-campus. The President can appoint members to the Radiation Safety Committee (RSC). The President may delegate functional responsibility to a qualified manager/administrator on-campus and has delegated this responsibility to the Radiation Safety Officer.

### 2.2 Radiation Safety Manual

The Radiation Safety Manual (Manual) serves as a guide for individuals using or having responsibility for the use of radiation sources, and contains the University's policy, organization, operating procedures and standards for the Radiation Safety Program. The Manual addresses most of the conditions stipulated in the University's License for the use of radioactive materials. The applicable governmental regulations are found in the California Code of Regulations (CCR) Title 17 and in the Code of Federal Regulations (CFR) Title 10 Part 20. The Manual is part of the University's radioactive materials license and as such must be strictly followed. Both the regulations and the campus License are available for review in the Department of Environmental Health and Safety, or by contacting the Radiation Safety Officer.

Each Authorized User (AU) of radioisotopes will be given at least one (1) copy of this Radiation Safety Manual at the time her or his initial approval as an AU. The official copy shall be kept on-campus for reference and training purposes. The appropriate campus administrators will also receive a copy.

### 2.3 Radiation Safety Committee (RSC)

2.3.1 Committee Composition and Responsibility. The RSC is composed of Authorized Users, an administrative representative, and the RSO. The Chairperson of the RSC is specifically named on the University's Radioactive Material License (License).

The RSC is responsible for reviewing and subsequently approving/rejecting proposed uses of radiation and radionuclides; and generally ensuring that the Radiation Safety Program is effective. The RSC will support the RSO when it is necessary for the RSO to assert authority. If the RSC has overruled the RSO, it will record the basis for its action in the minutes of the quarterly meeting. The RSC will delegate authority to the RSO for enforcement of the ALARA program. The committee will encourage AU's to review ALARA procedures as often as appropriate to ensure a successful ALARA program.

The RSC will perform a quarterly review of occupational radiation exposure with particular attention to instances in which the investigational levels in Table 1 (next page) are exceeded. The principal purpose of this review is to assess trends in occupational exposure as an index of the ALARA program quality and to decide if action is warranted when investigational levels are exceeded (see Section 2.4.1 on the next page for a discussion of investigational levels).

The RSC will evaluate the institution's overall efforts for maintaining doses ALARA on an annual basis. This review will include the efforts of the RSO, Authorized Users, and workers as well as those of management.

Table 1  
Investigational levels\*

	Investigational Levels (mrems per calendar Quarter)	
	level I	level II
1. Whole body; head and trunk; active blood-forming organs; lens of eyes; or gonads.	125	375
2. Hands and forearms; feet and ankles	1,875	5,625
3. Skin of whole body	750	2,250
4. Thyroid uptake	0.1 microcurie	0.3 microcurie

\* Note that investigational levels in this program are not new dose limits but serve as checkpoints above which the results are considered sufficiently important to justify investigations. See Section 2.4.1 for information on investigation requirements.

The RSC may choose to exclude from regulation some "exempt" or "General License" sources of radiation.

- 2.3.2 Meeting Frequency and Quorums: The RSC shall meet at least quarterly (two times per semester) to review the activities of the Radiation Safety Program and to consider other related matters. Special situations may warrant additional RSC activity e.g. new Authorized User applications, etc. A quorum shall be present at all meetings, consisting of a majority of the membership, and will include the RSO.
- 2.3.3 Approval of Authorized Users: A majority vote is required in order to approve any AU, thus ensuring that the type and quantity of radionuclides requested, the proposed use, and the experience of the personnel involved adequately comply with standards for radiation protection with specific attention given to the ALARA principle.

## 2.4 Radiation Safety Officer (RSO)

- 2.4.1 Responsibility: The RSO is assigned responsibility, generally subject to review by the RSC, for control of applicable campus activities, monitoring of radiation and contamination levels, and providing services in radiation control in conformity with government regulation and the policies and standards set forth in this Manual. The RSO may delegate some tasks to appropriately trained individuals. The Radiation Safety Officer is specifically named on the License.

The RSO is responsible for all aspects of radiation control on the campus. The RSO is a member of the RSC and carries out the directives of the Committee, refers matters to the committee for review and approval, and reports to the committee on the overall status of the Radiation Protection Program. Each application for AU status or

amendment thereto is reviewed by the RSO and forwarded to the Committee for further consideration.

The RSO shall conduct an annual review of the Radiation Safety Program, including the ALARA practices, and shall report the finding of the review to the RSC. The RSO will review the occupational exposures at least quarterly and report the summary of that review to the RSC. The RSO will review radiation surveys in unrestricted and restricted areas to determine that dose rates and amounts of contamination were at ALARA levels during the previous quarter and will prepare a summary report for the RSC.

The RSO is responsible for the review of campus compliance with State and University policies on radiation protection and for informing the RSC and/or President/designee on matters related to radiation safety as appropriate. The review will cover operating procedures and past dose records, inspections, and recommendations to the radiation safety staff or consultants. The RSO will modify operating and maintenance procedures, equipment, and facilities if these modifications will reduce exposures and the cost is justified.

The RSO (in cooperation with Authorized Users) will ensure that radiation workers and, as applicable, ancillary personnel are trained and educated in good health physics practices and procedures. The RSO will schedule briefings and educational sessions to inform workers of the ALARA program efforts. The RSO will ensure that Authorized Users, workers, and ancillary personnel who may be exposed to radiation will be instructed in the ALARA philosophy and informed that management, the RSC, and the RSO are committed to implementing the ALARA concept. The RSO will investigate all known instances of deviation from good ALARA practices and, if possible, will determine the causes and will implement changes in the program to maintain doses ALARA.

Except when deemed appropriate by the RSO, no further action will be taken in those cases where an individual dose is less than Table 1 values for the Investigational Level I. The RSO will review the dose of each individual whose quarterly dose exceeds Investigational Level I, and will report the results of the reviews at the first RSC meeting following the quarter when the dose was recorded. If the dose does not equal or exceeds Investigational Level II, no specific action related to the exposure is required unless deemed appropriate by the Committee. The Committee will, however, review each such dose in comparison with those of others performing similar tasks as an index of ALARA program quality and will record the review in the Committee minutes. The RSO will investigate in a timely manner the causes of all personnel doses equaling or exceeding Investigational Level II and, if warranted, will take action. A report of the investigation and any actions taken will be presented to the RSC at its first meeting following completion of the investigation. The details of these reports will be included in the RSC minutes. In cases where a worker's or a group of worker's doses need to exceed an investigational level, a new, higher investigational level may be established for that individual or group on the basis that it is consistent with good ALARA practices. Justification for new investigational levels will be documented. The RSC will review the justification for and must approve or disapprove all revisions of investigational levels.

- 2.4.2 Authority: The RSO is empowered by the RHB to stop any use of any source of radiation on the campus, and impound any materials/equipment involved when she/he determines that a significant breach of safety or of procedures or license conditions is taking place. RSO actions are subsequently open to review by the RSC.

## 2.5 Responsibilities of the Authorized User

Each Authorized User is personally responsible for compliance with University and governmental regulations as they pertain to her/his authorized use of ionizing radiation. Specific responsibilities include the items listed below.

- 2.5.1. Notifying the Radiation Safety Officer, and/or University Police of the loss or theft of a radiation source, or unsafe conditions beyond the control of the Authorized User, e.g. gross contamination, excessive exposure, suspected ingestion, etc.
- 2.5.2 Obtaining RSO approval in writing before acquiring radioactive materials, gas chromatographs with electron capture detectors, liquid scintillation counters or any other device containing a radiation source (e.g. moisture detector, thickness gauge etc.). The authorization should be on the form "Authorization to Purchase or Accept Radioactive Materials or Radiation Producing Devices" which is listed in Attachment 1.
- 2.5.3 Keeping and/or submitting required records for inspection at reasonable times by the RSO or regulatory inspectors. These records will include:
- a) Receipt and disposal of radionuclides.
  - b) Select surveys of laboratories and workplaces, including radiation and/or contamination levels.
  - c) Training records for personnel engaged in radiation work under the responsible Authorized Users' supervision, with training for specific laboratory procedures documented as necessary.
- 2.5.4 Ensuring that all personnel who frequent areas under their supervision receive the appropriate level of instruction in basic radiation safety.
- 2.5.5 Ensuring that radioisotope use and storage is limited to locations, protocols, nuclides, chemical/physical forms and amounts listed in the protocol(s) approved by the RSC.
- 2.5.6 Placing and maintaining required warning signs and labels as appropriate on doors, refrigerators, freezers, incubators, equipment, tools, benches, waste containers etc.
- 2.5.7 Enforcing the appropriate use of protective clothing and equipment, survey meters, and dosimeters as specified in this Manual or by the RSO/RSC.
- 2.5.8 Preparing radioactive wastes for disposal in accordance with approved procedures, properly labeling the waste and filling out waste logs as appropriate. See Section 13 for additional information.

## 2.6 Responsibilities of the Radiation Worker

Each person who works with a source of ionizing radiation is responsible for keeping radiation exposures to herself/himself and others "As Low As Reasonably Achievable" (ALARA). The worker will also know and observe all appropriate radiation safety precautions, suggest improvements to ALARA practices and for work within the provisions of the approved protocols. Any deviations from ALARA principals or safety issues shall be reported to the responsible Authorized User or RSO.

## 2.7 Purchasing, Shipping and Receiving, Property and Foundation

All persons must obtain RSO approval prior to bringing any radiation source onto campus, including donated items. Orders for radioactive materials or radiation producing machines must bear the signature of the RSO, and the words "Radioactive" or "X-Ray" as appropriate. The Purchasing Department, Shipping and Receiving, Property and Foundation Office are conduits for the acquisition, through established procedures, of most radioactive materials and equipment capable of producing ionizing radiation. They must ensure that RSO approval is obtained prior to processing any transactions involving the above items. The RSO will determine whether the person requisitioning or accepting any radioactive material or radiation producing equipment is authorized to possess and use it. For more information, see Sections 4.0. "Radioactive Materials Acquisition, Delivery, Custody, and Inventory" and 5.0 "Radiation Producing Machines."

## 3.0 AUTHORIZATION TO USE IONIZING RADIATION

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### 3.1 Authorized Use of Radioactive Materials

No person shall use radioactive materials or radiation producing machines without prior approval from the RSO and/or RSC.

#### 3.1.1 Applications for Human, Research, Classroom, and Animal Use:

a) Human Use:

The administration of radioisotopes, internally or externally, to humans is not permitted. The Student Health Center is the only campus entity authorized to administer ionizing radiation (in the form of diagnostic x-rays) to humans.

b) Research Use:

Applications requesting permission to use radioactive materials for research purposes shall be submitted to the RSO and RSC well in advance of the anticipated date of use. Research includes Authorized User projects, directed student projects, graduate projects, etc.

c) Classroom Use:

Applications requesting permission to use radioactive materials for teaching or demonstration in academic courses must be submitted to the RSC and RSO well in advance of the anticipated date of classroom radioisotope use. Special procedures may be required due to security and/or multiple use problems associated with most teaching areas.

d) Animal Use:

Applicants requesting permission to administer radioactive materials to animals should consider the following:

- 1) Animals administered radioactive materials shall be housed separately from other animals. Aquaria, cages etc. shall be labeled with appropriate radiation warning signs. Information on the label shall include the name of the person responsible for the experiment, the isotope and quantity, and date of administration. Authorized Users who plan to work with live vertebrates should also submit the appropriate application to the Institutional Animal Care and Use Committee well in advance of their intended start date.
- 2) Radioactive excreta, animal carcasses and tissues, contaminated cage bedding, etc., will be handled as "Animal Waste" in accordance with current radioactive waste disposal procedures, and with any additional stipulations from the RSO/RSC (see Section 13).
- 3) Authorized Users are responsible for ensuring that animal caretakers and custodians are aware of potential hazards and are adequately trained and supervised.

#### 3.1.2 Procedure for Becoming an Authorized User (AU):

a) Submittal of Application:

In order to become an Authorized User (AU) for projects involving the receipt,

possession, and/or use of controlled radioactive materials, a "Proposed Use of Radioactive Materials" form must be submitted to the RSC via the RSO. If you are a first time applicant, you will also need to submit a "Statement of Training and Experience" form RH 2000A. Authorization is only granted to University or Foundation employees and occasionally volunteer or adjunct employees. The applicant must have accrued a minimum of 40-hours of training and/or experience in radiation safety and safe handling techniques. Authorization cannot be transferred to another person and is required without regard to whether items are procured by purchase, loan, gift, or previous ownership. Authorized User application packets are available from the Radiation Safety Officer.

b) Application Review Process

The RSO first reviews all applications to ensure that the appropriate safety issues have been adequately addressed. The RSO will then forward the application to the RSC for consideration. The following key parameters will be considered by the RSO and RSC:

- 1) applicant's training and experience:  
40-hours minimum documented training and experience (prior authorizations at similar facilities, classroom training...);
- 2) training and experience of project personnel:  
who will be working under the Authorized User;
- 3) the nature of the requested facility(ies):  
is the lab currently designated as a radioactive materials area;
- 4) adjacent facility uses:  
what impacts would the proposed use have on nearby areas;
- 5) radiation hazards and chemical toxicity of requested materials:  
the hazards must be addressed in protocol and training or reduced to a manageable level;
- 6) amount and concentration of radioactive materials:  
can micro scale processes be employed to reduce the activity requested;
- 7) past radiation safety findings:  
has the Authorized User been able to maintain compliance during history of use;
- 8) input from responsible interested parties:  
are there relevant objections to the proposed uses that need to be addressed as conditions of approval;
- 9) frequency of use:  
how frequently will the use take place and for what period of time.

The applicant must have accrued a minimum of 40-hours of training and/or experience in radiation safety and safe handling techniques.

3.1.3 Procedure for Renewal of Approved Use:

- a) Renewal requests must be made through the RSO. The RSO is responsible for assembling any data and documents needed to ensure an adequate review of the request by the RSC. Approved Uses must be renewed if:
  - 1) work with unsealed radioactive materials is to continue; or
  - 2) any unsealed radioactive materials are to remain in possession of the AU.
- b) Issues considered by the RSO/RSC during the review process will include the following:
  - 1) changes in the scope, location, or procedures of the project;

- 2) past compliance with pertinent regulations; and
- 3) changes in the type or quantity of radioactive materials authorized.

#### 3.1.4 Procedure for Amending Approved Use Procedures:

Proposed changes in use-locations, radionuclides, etc. must be submitted well in advance to the RSO, who will review the request or forward it to RSC for review, if necessary. Changes in use-location usually require approval from the appropriate administrator.

#### 3.1.5 Procedure for Terminating Approved Use (Closure):

- a) Approved Use will expire if not renewed, and may be terminated prior to the stated expiration date if the responsible Authorized User is found to be willfully or negligently in violation of the University's policies or governmental regulations. Upon termination, all radioactive work must stop and all radioactive materials are subject to impoundment by the RSO. The RSO's actions are subject to review and modification by the RSC. The Approved Use will normally be terminated prior to the expiration date upon completion of the Authorized Users' need for radioisotopes.
- b) An Authorized User terminating her/his Approved Use must, with the approval of the RSO, ensure that all unused radioactive material is transferred to another AU, placed in appropriate storage, or disposed of as radioactive waste. The AU must ensure the removal of all radioactive contamination on surfaces/equipment in the authorized area(s), and submit to the RSO a detailed radiation survey (see Attachment 2) indicating that all areas are free from contamination at levels described in NUREG, 1556, Vol. 11, Table S5. When it is determined that the area complies with these levels, the RSO will release the area as "unrestricted" and no longer under the guidelines of the Radiation Safety Program. The Authorized User must then remove all warning signs, labels, and postings.

## 3.2 Prenatal Radiation Exposure Policy

### 3.2.1 Exposure of Pregnant Women

- a. Federal and state regulatory agencies have established the category of Declared Pregnant Woman in order to address two competing objectives of national policy. These objectives are:
  - (1) The desire to establish a legal mechanism to offer special protection to the developing embryo/fetus by limiting external and internal doses to levels lower than those established for the mother.
  - (2) Decisions of the U.S. Supreme Court which prohibit the establishment of mandatory legal dose limits for women that are lower than the legal dose limits for men.
- b. Therefore, each woman must choose to become a Declared Pregnant Woman if she wants to have voluntary lower legal dose limits for the exposure of her developing embryo/fetus.
- c. CSU, Chico's procedures establish administrative criteria for external and internal dosimetry for declared pregnant women which are often lower (e.g., for penetrating gamma radiation emitters and most internal exposures) than those established for

adults who are not Declared Pregnant Women.

- d. Radiation emitted by external radionuclides that are pure beta emitters (e.g., which do not emit gamma rays) will not penetrate into the uterus. Therefore, external exposures of the embryo/fetus from P-32 and other beta emitters should not be of concern to prospective mothers.

### 3.2.2. Specific Information for Prospective Mothers

It is CSU, Chico's campus policy to inform female radiation workers (employees and students) of:

- a. The enhanced risks to the developing embryo/fetus from exposures to ionizing radiation.
- b. The options available to prospective mothers to maintain such exposures as low as reasonably achievable below the in utero legal limit of 500 millirems (for Declared Pregnant Women) during pregnancy for external and internal exposures.
- c. That all such workers are strongly encouraged to contact the EHS Office if they have any questions regarding radiation exposures during pregnancy.

### 3.2.3. Special Precautions for Prospective Mothers

Precautions required or recommended for prospective mothers (i.e., those who are pregnant or who are actively trying to become pregnant) who choose to continue working with or around radioactive materials and/or radiation-producing equipment, include:

- a. The prospective mother should avoid situations where her abdomen may be exposed to penetrating radiation (gamma, x-ray, neutron) levels greater than 2 millirems per hour or 10 millirems per week.
- b. Protective aprons may be worn, if appropriate for the energy and type of radiation encountered. Thin lead aprons may be used for x-rays, but they are not recommended for use with gamma emitters (such as Cr-51) or high-energy beta emitters (such as P-32).
- c. The EHS Office may issue a radiation dosimeter to a Declared Pregnant Woman to be used as a "fetal monitor" to assess penetrating radiation exposures (from external sources) to the prospective mother's abdomen whenever it is likely to receive a deep dose equivalent of more than 50 millirems in a year and the woman's usual dosimeter is likely to measure doses that are less than the doses to the abdomen.
- d. If the deep dose equivalent to the embryo/fetus of a Declared Pregnant Woman equals or exceeds 50 millirems per month for more than two consecutive months of a pregnancy, the prospective mother's work will usually be reviewed to determine if restrictions are necessary to reduce further exposures during the remainder of the pregnancy.
- e. If the dose equivalent to the embryo/fetus of a Declared Pregnant Woman exceeds 500 millirems during her pregnancy, the woman will normally be

required to avoid all further occupational and educational radiation exposure until after the birth of her baby.

- f. The prospective mother should avoid working with volatile or reactive radiochemicals, which could result in the inhalation, ingestion, or absorption of radioactive materials through her skin.
  - (1) While pregnant, she should not perform either iodinations using radioiodine or labeling procedures using tritiated water or tritiated borohydride.
  - (2) Nursing mothers should also avoid such procedures.
- g. In any case of suspected accidental exposure to radiation sources or uptake of radioactive materials, the prospective mother should contact the Department of EHS immediately, or call campus police after hours, or on weekends or holidays.

### 3.3 Non-Medical Use of Radiation Producing Machines

The RSC usually issues special authorizations to the primary Authorized Users of non-cabinet type x-ray machines. Written authorizations are not issued to the Authorized Users of electron microscopes. The RSO registers each operable electron microscope and radiation producing machine with the State RHB as required. These devices are regulated by the RHB, but are not part of the University's Radioactive Materials License.

### 3.4 Medical Use of Radiation Producing Machines

The use of diagnostic x-rays in the Student Health Center is not covered by the License. However, given the responsibility of the RSO to oversee all radiation safety on-campus, the RSO will oversee the use of the diagnostic x-ray unit.

This oversight shall be done with close consultation and support from the Director of the Student Health Center, the Certified X-Ray Technician, and the Radiation Safety Committee.

### 3.5 Conditions Requiring an Amendment to the License

Proposals for the use of radioactive materials involving any of the three (3) conditions listed below will require a formal amendment from the State RHB.

- Use of radionuclides not specifically included in the Campus License.
- Quantities of radionuclides in excess of the Campus License limits.
- Use of CSU, Chico's radioactive material at off-campus locations.

A written justification for any of the aforementioned conditions must be submitted by the RSO to the RHB, and a detailed safety protocol may be required. The license amendment must be obtained from the RHB prior to acquisition of the material or implementation of the new procedure. Since this amendment process typically takes several months, Authorized Users are encouraged to contact the RSO well in advance of the need of the modified license conditions.

### 3.6 Program Compliance Enforcement Policy

When the Radiation Safety Officer notes items of concern, the following steps will be taken:

1. The Authorized User is notified of any items of non-compliance with a request for timely correction. The timeline for correction will be determined by the Radiation Safety Officer.
2. If correction is not completed in a timely manner, notification is sent to the Department Chair by the Radiation Safety Officer / Radiation Safety Committee. A consultation is arranged with the Department Head and the Authorized User, and the items of non-compliance are clarified. Corrective procedures are determined with an approximate time frame for correction of items of non-compliance.
3. Upon completion of corrections for items of noncompliance, notification is sent to the Radiation Safety Officer.
4. A follow-up inspection is performed to determine compliance and the effectiveness of any corrective actions that have been completed.
5. If the Authorized User remains in non-compliance, the enforcement proceeding would progress to a consultation with the Dean of the College, the Department Chair, and the Authorized User. A rigid timetable for corrective action will be established.
6. If the corrective actions are not completed within the time frame established, the Authorized User status will be revoked. Corrective actions will be completed as needed and the Department and/or College will be responsible for any undue costs associated with the corrective actions. The radioactive material would be transferred to the possession of the Department of Environmental Health and Safety for storage or disposal.
7. Documentation of all enforcement procedures will be documented in the Authorized User's file, located in the Department of Environmental Health and Safety.

## 4.0

# RADIOACTIVE MATERIALS ACQUISITION, DELIVERY, CUSTODY, AND INVENTORY

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### 4.1 Acquisition of Radioactive Material

- 4.1.1 Each purchase of radioactive materials must be approved by the RSO. The RSO's approval is contingent upon the following:
- a) the requested radionuclide and form is authorized by the AU's Approved Use;
  - b) the amount requested, when added to the AU's current inventory, does not exceed the AU's possession limit and the total authorized by the University's License.
- 4.1.2 All RHB-regulated radioactive materials brought on-campus (regardless of funding source) must be identified and controlled in accordance with the provisions listed below. This includes the receipt of low-level radiolabeled materials/samples sent from off-campus. All orders or other requests for radioactive materials should include the following information:
- a) the identity of the shipping party (e.g. company or institution);
  - b) the identity of radionuclide(s);
  - c) the activity, in appropriate units (mCi, Ci, or Bq.);
  - d) the name of the Authorized User making the request;
  - e) the chemical and physical form of the radioactive material; and
  - f) an order or requisition number.
- 4.1.3 The Purchasing Department or Property Office shall alert the RSO when they become aware of requests to purchase, or have materials delivered, that have not been approved by the RSO. The RSO indicates approval by signing and dating the "Authorization to Purchase or Accept Radioactive Materials or Radiation Producing Devices" form.

### 4.2 Delivery of Radioactive Material

The Shipping and Receiving Department, delivery personnel, and/or the recipient shall notify the RSO of all radioactive material deliveries within one hour of receipt of the material. The Radiation Safety Officer will perform a package survey as required by State and Federal regulations. Custody of the radioactive materials may not be formally transferred to the responsible Authorized User until the RSO or trained designee has executed the current radioactive item receipt procedure as required by the regulations.

### 4.3 Custody of Radioactive Material

After an incoming radioisotope shipment is processed following the appropriate procedures, the radioactive material is transferred to the custody of the Authorized User, who then assumes complete responsibility for the material. The AU shall be responsible for the proper storage, labeling, inventory accounting, use, waste-management etc. of the material. Authorized Users who anticipate permanent or extended absence from the University are expected to notify the RSO in advance of departure. An alternate responsible party should be designated and the radioisotopes secured in place or transferred to the custody of the RSO.

A radioactive material logbook will be kept that indicates the disposition of the radioactive material at all time. At a minimum the logbook will include the original amount of material in

each container, the date material was removed for use, who removed the material, how much material was removed, and the disposition of the material, i.e. liquid waste, solid waste. Samples of logbooks can be obtained from the Radiation Safety Officer.

#### 4.4 Inventory of Radioactive Material

The RSO shall be responsible for keeping the master inventory records of all licensed radioactive materials. The RSO shall request inventory reports from the AU's annually. Inventories shall be kept current at all times so the RSO can determine maximum quantities on-site whenever requested or required.

#### 4.5 Transfer of Radioactive Material

The Radiation Safety Officer shall be notified prior to transferring radioactive materials from the Authorized User to a person, department, or project. Unauthorized transfer of radioactive materials may result in the revoking of the Authorized User's privileges and the impounding of the material. Radioactive Material Transfer forms shall accompany all transfers and one copy must be sent to the Radiation Safety Officer. The transfer form requires a signature from both authorized users. The transfer forms are available on the EHS website and in Attachment 6 of this manual.

Once the transfer of the radionuclide is approved the Radiation Safety Officer will review the transfer procedures with the Authorized Users involved in the transfer. All aspects of the transfer will be reviewed to ensure that ALARA principles are maintained at all times during the transfer.

Upon completion of the transfer, the Radiation Safety Officer will amend the radioactive material inventory kept in EHS. Both of the Authorized Users will also make the appropriate material inventory changes in their records.

## 5.0

# RADIATION PRODUCING MACHINES

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Departments or individuals considering the acquisition of a radiation-producing machine, whether it be the receipt of a donated item, a loan, or a purchase, shall obtain the approval of the RSO prior to bringing the item on-campus. Failure to register the machine and establish appropriate safety measures is a violation of State law.

### 5.1 Purchase and Acquisition

5.1.1 Electron microscopes and x-ray machines are classified as "Restricted" items. Acquisition shall be contingent upon RSO approval. The RSO is responsible for registering each radiation-producing machine on-campus with the State Radiological Health Branch (RHB).

5.1.2 To apply for authorization to acquire or operate an x-ray machine or electron microscope, the following information must be forwarded to the University's RSO:

- a) Manufacturer and machine type (X-ray, EM, etc.)
- b) Model and serial number
- c) Year of manufacture
- d) Physical status (stationary or mobile)
- e) Operational status (disabled, operational, requires repair, etc.)
- f) Use or application (microscopy, materials testing, irradiation, diffraction analysis, etc.).
- g) Maximum operational voltage and current
- h) Estimated use per week (in hours)
- i) Principal Authorized User(s) or instructor(s), courses and proposed use-locations
- j) Safety provisions such as cabinet enclosure, shielding, interlocks, keys, warning lights etc.
- k) Identity of the appropriate administrators from whom approvals will be sought (Chair and Dean)

### 5.2 Postings and Warning Signals

Appropriate radiation caution signs shall be posted in the area prior to the operation of any radiation-producing machine (see Section 7). An initial radiation field survey will also need to be performed by the RSO or qualified contractor. Any machine capable of producing a dose rate in excess of 100 mR/week (1 mSv) in accessible areas shall be provided with a radiation activated warning signal or light. Such a signal or light will activate automatically only when a radiation field is present.

### 5.3 Operating Guides

All approved installations of teaching and research x-ray units shall have a specific operational procedure guide, which must be followed. The Authorized User is responsible for ensuring that all machine operators follow the guide and are appropriately trained. A factory operator's manual must be acquired for the device whenever possible.

#### 5.4 Exposure Limits

Exposure of individuals to radiation from machines shall be limited, as specified by law. See Section 10 for details.

#### 5.5 Transfer and Disposal

RSO approval is required prior to the transfer, disposal, or relocation of any Campus radiation producing machine. The RSO will ensure that the transfer is done in a proper manner and regulatory requirements/registration is in order. In the case of operational units moved off-campus, prior written approval from the receiving institution will be required.

## 6.0

# SHIPMENT OF RADIOACTIVE MATERIALS

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Shipments or travel with radioactive materials (such as radiolabeled tissue samples or radioisotope stocks) to and from the University must conform to pertinent license conditions and the appropriate State and Federal transportation regulations. Radiation Safety Officer approval must be obtained prior to any off-campus shipment of such materials from in order to ensure compliance with these regulations. The recipient of any shipped radioactive materials must hold a valid Radioactive Materials License that permits receipt of the materials being transported. Approval by the RSO/designee at the receiving institution is required prior to shipment.

## 7.0 SECURITY, LABELING AND POSTING OF RADIOACTIVE MATERIALS/AREAS

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### 7.1 Security: Loss and Theft Prevention

Regulated radioactive materials shall be stored in a manner that prevents unauthorized removal. Authorized Users and program personnel are required to maintain oversight of the radioactive materials, ensure that radioactive materials are secure from theft, and prevent access to radioisotope areas by unauthorized persons, e.g. lock doors of areas not under the oversight of a qualified person.

### 7.2 Labeling: Containers and Work Areas

All containers holding radioactive materials for storage, processing or use, shall be conspicuously labeled with the standard radioactive material symbol.



Labels should include the identity of the Authorized User or lab worker, radioisotope, maximum activity in microcuries, millicuries or Becquerels, and the date. Containers of improperly labeled radioactive materials are subject to impoundment by the RSO. Contaminated or potentially contaminated equipment dedicated to radioisotope use must also bear caution labels as described above.

### 7.3 Posting: Rooms, Equipment, and Storage Units

7.3.1 Any location where a dose of 5 mR/hr could be received at a distance of 30 cm from the radiation source must be posted as "Caution - Radiation Area" as well as "Caution - Radioactive Materials". Radiation safety will provide pre-printed caution labels upon request.

#### 7.3.2 Radioactive Material:

All rooms, refrigerators, hoods, and equipment in which radioactive materials are in use or stored shall be posted with the standard radioactive material symbol. Radioactive materials shall not be transferred nor used in an unauthorized area without specific approval of the RSO and subsequent appropriate posting. Radiation areas (>5mR or 0.05mSv/hr) must also be properly posted.

#### 7.3.3 Notice to Employees:

State Form RH 2364 "Notice to Employees" is permanently and conspicuously posted in laboratories that are approved for radioisotope use. Authorized Users and radiation workers should be familiar with its content.

#### 7.3.4 Emergency Procedures:

All areas designated as "Radioactive materials use area" shall post emergency procedures that are appropriate to their area, isotopes, use, and potential emergency that may be faced. Procedures shall incorporate the applicable information outlined in Section 15 of this manual.

## 8.0

## TRAINING

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### 8.1 Initial Radiation Safety Training

Authorized Users are responsible for ensuring that adequate instruction in basic radiation safety is given to every employee or student who may be exposed to ionizing radiation, or have contact with potentially contaminated surfaces originating from the Authorized Users activities. Training issues pertaining to the protection of oneself and others are especially important. Radiation safety training must be documented. Standardized forms are available from the Radiation Safety Officer. A knowledgeable escort may be provided in-lieu of training for the occasional visitor. The RSO will assist in basic radiation safety training by offering periodic training sessions.

8.1.1 Initial radiation safety training should include the following information:

- a) Identification and location of areas where radioactive materials are stored.
- b) Potential hazards associated with radioactive material.
- c) Radiological safety procedures appropriate to each individuals role.
- d) Pertinent regulations.
- e) University License requirements and conditions.
- f) Their role and obligations.
- g) Emergency procedures.
- h) Location of license, regulations, and other pertinent documents.
- i) The University's ALARA program.
- j) Annual dose limits
- k) Pregnancy policy

8.1.2 Timing and Documentation of training:

- a) Before entering or working in radiation areas.
- b) During annual refreshing training.
- c) When significant change has occurred in duties, license, or applicable regulations.

### 8.2 Continuing Education/Refresher Training

8.2.1 Project Personnel:

Authorized Users are responsible for both project-specific and general radiation safety training for persons affected by their program. Authorized Users are also responsible for implementing and communicating to all appropriate personnel any new policies or procedures issued by the Radiation Safety Officer.

8.2.2 Authorized Users:

Authorized Users are required to participate in radiation safety refresher training activity each year. The training will be of sufficient length and of applicable material to be beneficial to the University's Radiation Safety Program. This training may be either live, videotaped, or a written exercise etc., and will be coordinated by the RSO and conducted by technical experts, qualified researchers, administrative representatives, the RSO or representatives from regulatory agencies. Topics of instruction include, but are not limited to the following: RSO program audit reports, radioactive waste, regulatory requirement updates, biological effects, radiation physics, environmental issues, ALARA techniques, radiation detection equipment, recordkeeping, and training tips for project workers.

### 8.3 Training Documentation

All training shall be documented. All training documents related to the radioactive materials program shall be held for no less than three years. These training records will be available to the RSO, RSC members, or any representative from a regulatory agency having oversight responsibilities. The RSO should be consulted prior to the disposal of any training records.

### 8.4 Exceptions to Training Requirements

Those using only  $^{63}\text{Ni}$  containing electron capture detectors will not be designated as Authorized Users, and therefore will be exempt from the training requirement as long as they are not involved in handling or changing the source.

## 9.0

## BASIC RADIATION SAFETY RULES

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### 9.1 Keep All Radiation Exposures As Low As Reasonably Achievable (ALARA)

The term ALARA is an acronym for maintaining radiation exposures, and effluent releases of radioactive material in uncontrolled areas "As Low As Reasonably Achievable" taking into account the available technology, economic costs in relation to benefits to the public health and safety considerations in their relationship with the utilization of radioactive materials and radiation-producing equipment in the public interest.

### 9.2 Control and Reduce External Exposure

Design and conduct all operations with radioactive materials to provide the maximum protection of both personnel and laboratory surfaces. Prior to working with radioactive material, estimate the potential radiation dose by measuring the highest radiation rate and factoring in the expected time of exposure. External radiation exposure from a given radioactive source is controlled by keeping three rules in mind: TIME, DISTANCE and SHIELDING.

- 9.2.1 Decreasing the TIME of exposure decreases the radiation dose proportionately. Practicing "dry runs" with non-radioactive material prior to actually working with radioisotopes will increase the worker's efficiency and give a good idea of the expected exposure time.
- 9.2.2 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 radiation. The radiation field varies inversely with the square of the distance. For this reason, tongs or other long-handled tools should be used for manipulating radionuclide preparations emitting significant levels of radiation. Highly energetic radioactive materials should never be picked up with the fingers; the use of short forceps considerably reduces exposure. Placing notebooks and other reference materials out of the high exposure area will also significantly reduce exposure.
- 9.2.3 SHIELDING the source of radiation will be necessary when exposures cannot be reduced to minimal levels by simply increasing working distance and decreasing exposure time. Shielding is accomplished by putting appropriate materials between you and the radiation source.
- a) Gamma radiation is best shielded by using appropriate amounts of dense materials, typically lead bricks, lead sheets, leaded glass, etc; however, steel, glass, or even water can provide some shielding.
  - b) Beta radiation is more easily shielded. A few millimeters of solid material is sufficient to totally absorb most commonly encountered beta radiations. High-energy  $^{32}\text{P}$  beta emissions can produce penetrating x-rays called Bremsstrahlung when shielded by thin lead or steel. Less dense materials such as plastic or glass should be used for shielding  $^{32}\text{P}$  whenever possible. When working with energetic beta emitters, care must be taken to avoid exposing hands above open containers where the dose rate can be rems (or sieverts) per hour for commonly used quantities of beta emitters such as  $^{32}\text{P}$ .

### 9.3 Eliminate the Potential for Internal Exposure

Incorporation of radioactive material into the body by inhalation, skin absorption, or ingestion is easily prevented by following the radiation protection rules listed below. Inhalation of radioactive material can be prevented by using a properly functioning fume hood when handling volatile or aerosolized radioisotope solutions, or when handling large quantities of non-volatile, unsealed radioactive materials.

- 9.3.1 Keep the appropriate survey meter turned on when using radioisotopes other than  $^3\text{H}$ ; frequently check gloves, work areas, equipment etc. for contamination. Turn switch to "bat" to make sure the battery is good, then check meter function with a radiation source. Personal dosimeters may be issued to quantify exposure when higher energy radiation sources are used. Orient dosimeters to receive the maximum dose you are exposed to during the procedure. (See Attachment 2, Page 16-4.)
- 9.3.2 Wear lab coats and impermeable gloves when working with radioactive material. Avoid exposure from contamination by changing gloves as frequently as needed, and never wear contaminated lab coats etc. Additional protective equipment and/or garments, commensurate with the hazard potential, will be required by the RSO/RSC as necessary.
- 9.3.3 Wear fully enclosed chemical splash goggles, if splash to the eye is possible when working with radioactive liquids.
- 9.3.4 Keep radioactive solutions and waste in capped or otherwise sealed containers when not in immediate use.
- 9.3.5 Work with radioactive material in a properly operating fume hood when necessary.
- 9.3.6 Store and transport containers of radioactive solutions in trays or buckets.
- 9.3.7 Line trays and working surfaces with absorbent paper as appropriate. Absorbent "benchcote" paper with plastic backing is best; place absorbent side up!
- 9.3.8 Clearly label containers of radioactive material and post all radioisotope use/storage areas with the standard radiation warnings. See Section 7 - Security, Labeling and Posting of Radioactive Materials/Areas..
- 9.3.9 Conduct work with radioactive materials in accordance with the Authorized Users Approved Procedures.
- 9.3.10 Perform "dry runs" of new procedures with non-radioactive items before using isotopes.
- 9.3.11 Survey work areas after handling radioactive materials. See Attachment 2 for an example survey form and instructions on how to conduct a survey. Keep records of such surveys as required. See Section 11 – Radiation Safety Program Audits.
- 9.3.12 Clean-up spills promptly.
- 9.3.13 Do not eat, drink, smoke, store food/drink/tobacco products, or apply or store cosmetics in areas where unsealed radioactive materials are used or stored. Wash-hands thoroughly after working with radioactive materials even when gloves were worn.

- 9.3.14 Do not pipette by mouth.
- 9.3.15 Monitor the hands whenever contamination is suspected and decontaminate immediately if contamination is present. Change gloves often.
- 9.3.16 Authorized Users are required to perform wipe tests at the end of experiments utilizing Tritium and/or Carbon 14 to ensure that there is no contamination present. If contamination is present, the area that is contaminated must be decontaminated to acceptable limits. Acceptable limits may vary depending on location. See Section 9.4 Release of Restricted Areas for Unrestricted Use.
- 9.3.17 Authorized Users shall perform ALARA monitoring with appropriate survey instruments (GM) every time radioactive materials are used or specify and justify the times when it is not appropriate (This is an ALARA survey and does not need to be documented). When Authorized Users feel it is not appropriate to conduct this monitoring, the reasons should be included in their lab protocol.

#### 9.4 Release of Restricted Areas for Unrestricted Use

Within the laboratory, contamination control will be required. Consequently, the following types of areas and limits are established:

- 9.4.1. Controlled Areas: Controlled areas are areas where radioactive material is used or stored. The contamination limits for a controlled area are as follows:

< 60 cpm/100 cm<sup>2</sup> above background for beta-gamma emitters.

< 18 cpm/100 cm<sup>2</sup> above background for alpha emitters.

OR

< 220 dpm/100 cm<sup>2</sup> above background for beta-gamma emitters.

< 22 dpm/100 cm<sup>2</sup> above background for alpha emitters.

- 9.4.2 Small Contamination Control Zone: A small contamination control zone (defined work area) is a small area where unsealed radioactive materials may be used. The contamination limits for this type of area are as follows:

< 300 cpm/100 cm<sup>2</sup> above background for beta-gamma emitters.

< 88 cpm/100 cm<sup>2</sup> above background for alpha emitters.

OR

< 1100 dpm/100 cm<sup>2</sup> above background for beta-gamma emitters.

< 110 dpm/100 cm<sup>2</sup> above background for alpha emitters.

#### 9.5 Release of Restricted Areas for Unrestricted Use

When an Authorized User no longer wishes to use radioactive materials and would like to return the use location to an unrestricted use area, or as soon as contamination is found in unrestricted areas, notify the Radiation Safety Officer. Contamination found in unrestricted areas should be immediately decontaminated to background levels.

When it is not possible to get to background levels, the Authorized User in conjunction with the Radiation Safety Officer must ensure that the amounts do not exceed the contamination levels listed in NUREG, 1556, Vol. 11, Table S5. Surface contamination surveys should be conducted for both removable and fixed contamination before these facilities or equipment are released from restricted to unrestricted use, to ensure that they meet these limits.

## 10.0 EVALUATION OF INTERNAL AND EXTERNAL DOSE

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### 10.1 External Exposure from Radioactive Materials or X-Ray Machines

10.1.1 The RSO will monitor occupational exposures to radiation, and issue and require the use of individual monitoring devices in accordance with applicable regulations. See Attachment 2 for more information on dosimetry badges used at the University.

10.1.2 Personnel exposure data will be a part of the permanent records of the Radiation Safety Program. All radiation workers have access to her/his own dosimetry records. Dosimetry reports will be available for review in the EHS Department. Badged personnel are encouraged to review their exposure reports. Any exposure over 60 millirems (0.6 mSv) will be reported in writing to both the exposed individual and the Authorized User. Upon request of any employee or student, the RSO will provide a report summarizing his/her exposure to radiation as shown in the dosimetry records. Additionally, in any case where exposure of an individual to radiation must be reported to the State Radiologic Health Board pursuant to regulations, the RSO will notify the individual in writing as to the nature and extent of the exposure.

### 10.2 Internal Exposure from Unsealed Radioactive Materials

#### 10.2.1 Bioassay Policy, General:

Bioassays are tests designed to help quantify the dose received from ingested, inhaled, or absorbed radioactive material. Radiation Safety personnel will monitor known or suspected occupational intakes of radioactive material by, and assess the committed effective dose equivalent to, individuals who may have exceeded or are likely to exceed the limits specified for radiation workers as set forth in 10 Code of Federal Regulations (CFR) Part 20. Suitable and timely measurements used for determination of such internal exposures shall be performed as specified by the applicable regulations. Bioassays may also be performed upon request for any individual. Most bioassays involve analyzing urine specimens for radioisotope content. Radioiodine bioassays measure thyroid uptake.

#### 10.2.2 Bioassay Policy, Radioiodine:

Any individual contemplating the use of  $^{125}\text{I}$  must comply with the following bioassay procedure and pertinent instructions.

##### a) Types of Radioiodine Bioassays:

##### 1) Operational Bioassays:

Operational bioassays are typically performed at the beginning of select operations to determine if intake of radioactive materials has occurred due to the use of new processes or equipment. Radiation Safety personnel/committee members will evaluate the potential for intake and determine when operational bioassays are appropriate. The results of the operational bioassays will be used in evaluating the requirements for future bioassay requirements.

##### 2) Confirmatory Bioassays:

Confirmatory bioassays may be voluntarily performed, or required at the discretion of radiation safety, to verify that radiation safety control measures are keeping internal doses well below the levels where bioassays would be

required by NRC/California regulations. Confirmatory bioassays are applicable for individuals using 5 mCi or 185 MBq or less (0.1 mCi or 3.7 MBq for pregnant women and minors) of  $^{125}\text{I}$  in a volatile form, or 10 mCi or 370 MBq (5 mCi or 185 MBq for pregnant women and minors) of  $^{125}\text{I}$  in a nonvolatile form.

3) Routine Bioassays:

Routine bioassays are performed in accordance with regulatory requirements to assess intakes of radioactive materials and, as appropriate, to calculate internal doses. Routine bioassays shall be performed within 72-hours of any individual using in excess of 5 mCi or 185 MBq (0.5 mCi or 18.5 MBq for pregnant women and minors) of  $^{125}\text{I}$  in a volatile form, or 10 mCi or 370 MBq (5 mCi or 185 MBq for pregnant women and minors) of  $^{125}\text{I}$  in a nonvolatile form.

4) Diagnostic Bioassays:

Diagnostic bioassays are performed to characterize an intake of radioactive materials following suspected ingestion or a significant result from a bioassay measurement.

b) Bioassay Documentation and Interpretation:

A thyroid bioassay logbook will be maintained with the following parameters: name, date, amount of  $^{125}\text{I}$  handled, quality assurance check, background level, and gross counts. Thyroid burden and dose are calculated as appropriate.

c) Action Levels:

1) Anyone whose bioassay indicates a thyroid burden of 2 or more nCi (7.4 e-3 KBq) is required to work with Radiation Safety personnel to evaluate the radioiodine handling procedures, and discuss possible measures to keep future exposures ALARA.

2) Anyone with a bioassay measurement above the Recording Level (an intake leading to a Committed Effective Dose Equivalent (CEDE) of 10 millirems or 0.1 mSv) will undergo diagnostic bioassays as appropriate to confirm the finding, further document the event, and facilitate dose calculations.

3) If the accumulated CEDE during the year reaches 500 millirems or 5.0 mSv (100 millirems or 1.0 mSv for a declared pregnant woman or a minor), an investigation will be conducted to determine if the resulting dose is ALARA.

d) Recordkeeping and Internal Dosimetry:

Individual bioassay measurements indicating a thyroid burden of less than 2 nCi (7.4 e-3 KBq) will be entered in the log, but thyroid burden and dose totals need not be calculated. Individual bioassay measurements indicating a thyroid burden at or above the 2 nCi level but below the Recording Level will have the thyroid burden calculated, but dose totals need not be calculated. Individual bioassay measurements where the results are above the Recording Level will have the individual dose totals calculated as appropriate. If the accumulated CEDE during the year is 1 rem (10.0 mSv) or more, the maximum organ Committed Dose Equivalent (CDE) will be calculated and documented as part of the worker's lifetime dose.

e) Radioiodine Dose Assessment:

For typical use at the University, the regulatory requirements for  $^{125}\text{I}$  -related internal dosimetry primarily involve recordkeeping.

- 1) Nearly all bioassays are operational or confirmatory bioassays for internal Campus administrative purposes.
  - 2) A review of current and past radioactive materials projects and bioassay data indicates that no individual is likely to receive an internal dose that would require bioassays under Federal or State regulations.
- f) Equipment:  
When the University requires the use of radioiodine bioassay equipment, it shall contract with a company that is certified/licensed to accomplish the required tasks.
- g) Quality Assurance:  
When the University requires the use of radioiodine bioassay equipment, it shall contract with a company that is certified/licensed to accomplish the required tasks and will ensure that their thyroid monitoring equipment operates within the limits stipulated by State and Federal regulations i.e. performs with a value between 0.1 and 0.9 according to the Chi-square test. A  $^{129}\text{I}$  test-source is measured in the neck phantom prior to each bioassay to confirm that the equipment is functioning properly and is in calibration.

### 10.3 Radiation Monitoring and Campus Standards

#### 10.3.1 Radiation Levels:

Dose to individuals will be controlled in accordance with 10 CFR Part 20. The RSC limits projects to ensure that doses to personnel are minimal.

#### 10.3.2 Authorized User Radiation Monitoring Responsibilities:

- a) Authorized Users are responsible for ensuring that radioisotope work areas listed in their Approved Procedures are in compliance with State limits regarding radiation fields and worker exposures, and that all work is performed in accordance with the University's ALARA policy. Surveys and decontamination activities must be performed by qualified persons.
- b) Each Authorized User shall have ready access to survey instrument(s) capable of detecting hazardous amounts of the radiation/radioactive materials used in their program. These instruments shall be operational, in calibration, and continuously available. Instrument manuals, efficiency data, and replacement batteries are available from the Radiation Safety Officer.
- c) Documented radiation level surveys and/or contamination checks as appropriate shall be performed at least semi-annually in areas where unsealed radioisotopes are handled/stored.

## 11.0

## RADIATION SAFETY PROGRAM AUDITS

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In order to monitor compliance with safety principles and rules, the RSO/designee shall periodically, but not less than one-time per year, perform comprehensive audits of Authorized Users' radioisotope programs. A more frequent audit frequency can be set if determined beneficial by the RSC based on the frequency of use of radioactive materials, past audit findings, radioisotope amount, toxicity, etc. The audits will focus on the issues listed on the sample audit form included in Attachment 3 of this Manual.

## 12.0 CALIBRATION OF COUNTING/SURVEY EQUIPMENT

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### 12.1 Portable Equipment

12.1.1 Authorized User survey meters must be calibrated at least once per year. A simple meter function-check with a radiation source will be performed by the RSO/designee during routine audits of Authorized User programs.

12.1.2 Calibration will be performed only by persons specifically licensed to do so.

### 12.2 Beta or Gamma Counters/Spectrometers

Beta and Gamma counters used by Radiation Safety staff for radiation safety purposes must be periodically calibrated and maintained through service contracts with qualified vendors, and/or have calibration confirmed through the use of reference sources as appropriate.

## 13.0

## DISPOSAL OF RADIOACTIVE WASTE

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### 13.1 Collection and Storage Areas

Central collection and storage areas for radioactive waste (radwaste) are under the exclusive control of Radiation Safety personnel. The RSO/designee will be responsible for packaging/handling of radwaste for off-campus shipment, but individual generators of radwaste must collect, segregate and store their waste as indicated below or as modified as necessary to comply with evolving regulations. The RSO/designee will dispose of radioactive-waste in accordance with State and Federal regulations (10 CFR 20 and 17 CCR).

### 13.2 Radioactive Waste Types

Each type of waste indicated below represents a unique waste-type. Waste types must not be mixed!! Biohazardous agents must be inactivated (bleach, autoclave, etc.) prior to disposal.

13.2.1 Long Half-Life Dry Solid Waste (1/2 life > 90 days, e.g.  $^3\text{H}$ ,  $^{14}\text{C}$ ,  $^{65}\text{Zn}$ ,  $^{109}\text{Cd}$  etc.): Long-life dry waste must be deposited in properly labeled containers provided by Radiation Safety. Free liquid, toxic material, or lead is NOT permitted. The containers are usually lined with yellow polyethylene bags labeled with red radiation warnings. Needles or other "sharps" must be sealed in puncture-resistant containers before placing in the waste drums. The waste containers and/or accompanying waste logs should indicate the identity of the isotope(s), an estimate of amount in microcuries, millicuries, or Becquerels for each isotope, the date the material was placed in the container, and the identity of the person depositing the waste. Non-radioactive waste ("old" non-contaminated benchcote, non-contaminated gloves, paper towels etc.) may not be placed in this waste stream; the volume must be minimized due to high disposal costs.

13.2.2 Short Half-Life Dry Solid Waste (1/2 life < 90 days, e.g.  $^{32}\text{P}$ ,  $^{33}\text{P}$ ,  $^{35}\text{S}$ ,  $^{59}\text{Fe}$ ,  $^{125}\text{I}$ ): Short-life dry waste must be deposited in properly labeled containers provided by Radiation Safety prior to pick-up. Free liquid, toxic materials, or lead is NOT permitted. The containers are usually lined with black, white, or clear polyethylene bags, which are NOT marked with radiation warnings. Needles or other "sharps" must be sealed in puncture-resistant containers before placing in the waste drums. The waste containers and/or accompanying waste logs should indicate the identity of the isotope(s), an estimate of amount in microcuries, millicuries, or Becquerels for each isotope, the date the material was placed in the container, and the identity of the person depositing the waste. Radiation labels should be rendered illegible before placing items in the drum (rolled into gloves, defaced with felt marker, etc).

13.2.3 Scintillation Vials: LSC vials should be tightly capped and stored in a well-ventilated section of the lab prior to pick-up by Radiation Safety personnel. The vials and/or accompanying waste logs should indicate the identity of the isotope(s), an estimate of amount in microcuries, millicuries, or Becquerels for each isotope, the date the material was placed in the container, and the identity of the person depositing the waste. If waste scintillation fluid is collected in a bottle, it is called ORGANIC WASTE (see below). Do not add aqueous materials, high activity dilutions, counting standards, or any other waste to this container. MAKE SURE THE SCINTILLATION FLUID IS

**NOT MISTAKENLY ADDED TO THE RADIOACTIVE AQUEOUS WASTE!**

- 13.2.4 Radioactive Aqueous Liquid Waste: NO SCINTILLATION FLUID, ORGANIC WASTE, OR CHLORINATED SOLVENTS ALLOWED! Dilute solutions of alcohols, organic acids and bases are allowed, but the pH should be kept at 7.5 or greater. Ether is not permitted. Containers for collecting, storing, and disposing of aqueous waste should be no larger than necessary and should be unbreakable or placed in a pan/tray, etc., to provide "secondary containment". Containers and/or waste logs should indicate the identity of the isotope(s), an estimate of amount in microcuries, millicuries, or Becquerels for each isotope, the date the material was placed in the container, and the identity of the person depositing the waste. Authorized Users may not dispose of this waste through the sewage system, with the exception of glassware rinse water from "dishwashing" procedures.
- 13.2.5 Radioactive Organic Waste: 100% Non-Halogenated: NEVER MIX WITH AQUEOUS WASTE! Used LSC cocktail is often the principle material in organic waste, but acetone, ether, or concentrated alcohols may be added. Phenol, chloroform, acetonitrile, methylene chloride etc. are NOT permitted. Store and label in the same manner as aqueous waste. Containers and/or waste logs should indicate the identity of the isotope(s), an estimate of amount in microcuries, millicuries, or Becquerels for each isotope, the date the material was placed in the container, and the identity of the person depositing the waste. In addition, mark "Flammable" as appropriate.
- 13.2.6 Radioactive Animal Waste (Carcasses, Tissues and Excreta): Authorized Users shall provide adequate and approved freezer storage for animal waste in plastic bags until the RSO has collected and disposed of the waste following current guidelines.

Please note: Permission from the RSO must be obtained prior to generating any waste which does not conform to the above descriptions, such as halogenated liquids, sealed sources, electron capture detectors, contaminated lead, etc., or waste containing significant quantities of hazardous chemicals. The RSO must be notified prior to generating unusually large volumes of waste material. Special procedures may require RSO and RSC approval.

## 14.0

**GAS CHROMATOGRAPH FOILS AND  
SEALED SOURCES OF RADIATION**

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Radioactive foils ( $^{63}\text{Ni}$ ,  $^3\text{H}$  etc. in gas chromatograph electron capture detectors) and sealed sources containing radioactive material in excess of exempt quantities shall be sampled and tested for external contamination and/or leakage, in accordance with regulatory requirements (usually every 6 months). Records of the results of such tests will be maintained by the RSO. Authorized Users may not relocate or dispose of a device containing such a radiation source without RSO authorization.

## 15.0 RADIOACTIVE MATERIALS EMERGENCIES

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### 15.1 Minor Spills of Radioactive Materials

Project personnel can usually address minor spills involving no significant skin contamination or physical injuries by following the decontamination procedures listed below:

1. Survey the area to determine the level and location of contamination. Note the readings.
2. Post the area with appropriate temporary warning signs if necessary.
3. Cordon off contaminated areas with caution tape and/or chalk.
4. Cover areas as appropriate with paper or benchcote to prevent spread of contamination.
5. Wear protective clothing such as lab coats, protective gloves, and shoe covers.
6. Remove "hot" spots first, working from the perimeter toward the center to prevent spreading contamination. Do not use excessive water since "run-off" or drips may spread contamination. Dispose of the moist contaminated paper towels in the "Dry Solid" waste; log the isotope(s) and amount in the customary manner. If both long- and short-life nuclides are mixed together in the spill/clean-up, dispose as long-life waste.
7. Take care not to track contamination around. Control traffic and check all persons leaving the spill area for contamination, paying particular attention to hands, and shoe soles.
8. Isolate and retain any mops, rags, brushes, and wash solutions until these have been monitored and declared free of contamination. These may need to be disposed of as radioactive waste.
9. For assistance, contact the RSO at x5126.

### 15.2 Major Radioactive Spills or Contamination Events

A radioactive incident should be considered "major" when it impacts an area not authorized for radioisotope work or cannot be readily cleaned up in a timely fashion by laboratory personnel, or when there is a significant or unknown hazard to individuals from external exposure, or radioactive material inhalation, ingestion, or skin absorption. Prompt response and clean-up will prevent the spread of contamination and reduce the hazards, inconvenience, and costs.

Major incidents should be addressed as follows:

#### 15.2.1 Notify the appropriate emergency personnel:

- a) During working hours, notify the RSO at x5126. **DO NOT LEAVE A VOICE MAIL MESSAGE AND ASSUME THAT ASSISTANCE WILL BE FORTHCOMING.** If the RSO is not available, call 9-911 to notify University Police.
- b) After working hours, call 9-911 to notify University Police.

15.2.2 If safe to do so, survey the area to identify contamination, then confine the spill.

- a) Make sure you are wearing a lab coat and protective gloves. Disposable coveralls are recommended.
- b) If the spill is a liquid, cover the spill with absorbent paper.
- c) If the spill is a dry material, place a dampened absorbent material (paper or towels) over the contamination, if safe to do so. Be careful to prevent loose contamination from becoming airborne. Trained personnel equipped with respirators may be required.

15.2.3 Minimize the threat of aerosol contamination if appropriate by turning off fans and hoods if possible, and closing the windows and doors. If airborne radioactive material presents an inhalation hazard, leave the area and wait for respirator-equipped personnel to arrive.

15.2.4 Survey shoes, lab coats, hands etc. before leaving the contaminated area. Remove and contain any contaminated clothing.

15.2.5 If skin is contaminated, flush with large quantities of water. Use a catch basin or sink or floor drain when flushing - not the floor/ground if possible.

15.2.6 Measure exposure levels. If the material spilled is causing high external radiation levels, move to an area of low dose rate.

15.2.7 Post warnings and divert traffic around all contaminated or high exposure areas as appropriate.

15.2.8 Begin decontamination as soon as is safely possible. Follow any instructions given by Radiation Safety personnel.

15.2.9 Do not leave the area or return to routine project work until authorized by the RSO.

### 15.3 Fires and/or Injuries Involving Radioactive Materials

Call 9-911 immediately to notify University Police. Be sure to mention the involvement of radioactive materials to the Dispatcher. Ask them to contact the RSO. It is the responsibility of the Dispatcher to notify the responding agency (Fire Department and/or ambulance) of the involvement of radioactive materials. The person reporting the accident (or other knowledgeable persons) should remain near the scene if possible, and assist by providing information as to the location, type, amount of radioactive materials involved etc.

## 16.0

## ATTACHMENTS

On the following pages are supplemental radiation safety documents. These documents may be copied and are available from the Radiation Safety Officer, x5126. These addenda are included in Authorized User manuals as appropriate and are subject to revision as regulations evolve. Contact the EHS Department to make sure you have the most current version.

Attachment 1	Authorization to Purchase or Accept Radioactive Materials or Radiation Producing Devices .....	16-2
Attachment 2	Radiation Survey/Wipe Sample Record.....	16-3
Attachment 3	Proper Care and Wearing Instructions for Dosimetry Badges.....	16-5
Attachment 4	Radioactive Materials Program Audit Form .....	16-6
Attachment 5	Pregnant Worker Declaration Form .....	16-8

ATTACHMENT 1

SECTION 16.1



Department of Environmental Health & Safety

**Authorization to Purchase or Accept Radioactive Materials or Radiation Producing Devices**

Purchase

Donation

Requested material or device: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

Requested by: \_\_\_\_\_ Phone: \_\_\_\_\_  
 End-User (if different): \_\_\_\_\_ Phone: \_\_\_\_\_  
 Department: \_\_\_\_\_ Phone: \_\_\_\_\_

**APPROVED** by the Campus Radiation Safety Officer Date: \_\_\_\_\_  
 Name: \_\_\_\_\_ Signature: \_\_\_\_\_

**DISAPPROVED** by the Campus Radiation Safety Officer\* Date: \_\_\_\_\_  
 Name: \_\_\_\_\_ Signature: \_\_\_\_\_

Reason for disapproval:

- End User is not an Authorized User
- Authorized User has not been authorized to use or possess this material/device
- Purchase would exceed Authorized User's approved material quantity limit
- Purchase would exceed CSU, Chico's Radioactive Material License's quantity limit
- CSU, Chico's radioactive material license does not allow for the possession of this material/device
- Other: \_\_\_\_\_

\* Please contact the campus Radiation Safety Officer at ext. 5126, or a member of the Radiation Safety Committee to proceed with the purchase or acceptance of this material or device. This denial is not necessarily final; it may be possible to take further steps to accomplish all the requirements set forth by the regulating agency, the University's License, or the Radiation Safety Manual.



ATTACHMENT 2

SECTION 16.2



Department of Environmental Health & Safety

**Radiation Survey/Wipe Sample Record**

NOTE: Instructions for conducting surveys printed on back of form.

Name: \_\_\_\_\_ Date: \_\_\_\_\_

Location (be as specific as possible): \_\_\_\_\_

Isotope(s) being used: \_\_\_\_\_ Detection Equipment \_\_\_\_\_

Draw a map of the area being surveyed. Indicate on the map, with sample numbers, where wipe samples are being taken.

Sample #	Count Time	Activity (DPM)	BKG (DPM)	Net Activity (DPM)	Counting Error	Comments – Indicate and Write Below

Comments: \_\_\_\_\_

## How to Conduct Radiation Contamination Surveys

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### General Instructions:

Laboratory Surveys are required after every experiment using unsealed sources.

Sketch the area that is surveyed in the space provided identifying relevant features such as storage areas, waste storage areas, and other prominent features.

Indicate the location of samples that were taken on the sketch.

Areas with contamination levels should be decontaminated immediately.

For isotopes not listed below determine survey procedures and submit procedures to the RSO for approval with your application to use radioactive materials.

**FOR  $^3\text{H}$ ,  $^{14}\text{C}$ ,  $^{35}\text{S}$ ,  $^{33}\text{P}$ ,  $^{203}\text{Hg}$  and  $^{109}\text{Cd}$  AUTHORIZED USERS:  
YOU MUST TAKE PAPER WIPES & COUNT IN THE LSC/GAMMA COUNTER!**

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1. USE THE HAND-HELD METER TO FIND ANY HOT SPOTS. Use a meter with the appropriate probe for isotopes being used. Remember, these meters cannot detect  $^3\text{H}$ .
2. Wipe at least five (5) areas with a piece of filter paper, add a "clean wipe" control vial, AND COUNT TODAY (Gamma counter for  $^{109}\text{Cd}$ , LSC for all others)! \* Include wipes on any hot spots you found in Step 1. Use one piece of filter paper for each area. Wipe the filter paper over 100 square centimeters. Do not forget freezer handles, doorknobs, sink tops, counters, equipment etc. Clean areas with more counts than background, re-wipe and count. \*Sometimes samples counted immediately after adding LSC fluid will give false, high readings; store the vials for two hours in the dark and re-count. If you still get high counts, it is time to clean!
3. Document your survey on the Radiation Survey/Wipe Sample Record form. If this was a monthly survey, mail the printout to the Radiation Safety Officer today.

**FOR  $^{32}\text{P}$ ,  $^{125}\text{I}$ ,  $^{65}\text{Zn}$ ,  $^{60}\text{Co}$ , and  $^{54}\text{Mn}$  AUTHORIZED USERS:  
JUST USE THE HAND-HELD SURVEY METER!**

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1. USE THE HAND-HELD METER TO FIND ANY HOT SPOTS. Make sure you use the correct meter! Use the meter with the flat or "pancake" probe, unless you are looking for  $^{125}\text{I}$ , in which case you need the meter with the appropriate probe. For high background areas, wipe with filter paper then survey the paper with the meter. Clean any areas that have more counts than background, then re-survey.
2. Document your survey on the Radiation Survey/Wipe Sample Record form. Mail the monthly surveys to the Radiation Safety Officer today.

## ATTACHMENT 3

## SECTION 16.3

Department of Environmental Health &amp; Safety

**Proper Care and Wearing Instructions for Dosimetry Badges****General:**

Dosimetry badges shall be worn whenever there is a potential for occupational exposure to radiation. When badges are not in use, they should be stored in an area without radiation from your activities (background exposure only) to prevent non-work related exposure. Keep in mind that some radiation sources will pass through some materials, e.g. desks, shelves, walls, etc. Exposure reports are legal documents of occupational exposure only.

**Lapel Badges: (RDC #83)**

1. The Albedo neutron detector portion of the badge detects neutrons, which have entered the body and have been scattered back out to the badge. Consequently, the badge must be placed as close to the body as is practical, and no more than 3/8 inch from the surface of the body. The badge must be worn with the clip side next to the torso, and positioned somewhere between the waist and shoulder on the front side of the body. Proper positioning is critical as it affects the ability of the badge to detect the reflected neutrons. The badge should not be worn on loose clothing, which could cause it to fall away from the body.
2. The badge position is less critical for monitoring gamma or beta radiation but should still be worn on the front of the body between the waist and shoulders. The badge should be normally worn at the body location likely to receive the highest level of exposure.
3. If it is necessary to use an unassigned badge, such as a visitor badge, or to reassign a badge please provide the necessary information on a Spare Dosimetry Assignment Form and enclose it when you return the badge. If you require a visitor badge, please contact EHS at ext. 5126.

**Finger Rings:**

1. The TLD detector chip is located under the name label of the ring; consequently, the ring should be worn with the label facing the source of radiation. If the User wears gloves, the ring should be worn under the gloves.
2. Care should be taken to use only the ring marked with the specified individual's name. Right and left hand rings are designated by the placement of an "R" or "L" in the upper right hand corner of the label.

## Radioactive Materials Program Audit Form



Department of Environmental Health &amp; Safety

# Program Audit

#	Category	Comments	Follow-up Required
1	<b>Management Oversight:</b> (Management support to radiation safety; RSC; RSO; program audits, including annual reviews of program and ALARA reviews; control by authorized users; appropriate follow-up on events and previous audit/inspection findings)		
2	<b>Amendments and Program Changes:</b> (Amendments to the license were properly implemented; if applicable, program and procedural changes were approved and implemented in accordance with license condition)		
3	<b>Facilities:</b> (Facilities as described in license; uses; control of access; engineering controls; calibration facilities; shielding; air flow)		
4	<b>Equipment and Instrumentation:</b> (Operable and calibrated survey equipment; procedures; 10 CFR Part 21)		
5	<b>Material Use, Control, and Transfer:</b> (Materials and uses authorized; security and control of licensed materials; and procedures for receipt and transfer of licensed material)		
6	<b>Area Radiation Surveys and Contamination Control:</b> (Radiological surveys; air sampling; leak tests; inventories; handling of radioactive materials; contamination controls;		

	records; and public doses)		
7	<p><b>Training and Instructions to Workers:</b> (Training and retraining requirements and documentation; interviews and observations of routine work; staff knowledge of all routine activities; 1- CFR Parts 19 and 20 requirements; emergency situations; and supervision by authorized users)</p>		
8	<p><b>Radiation Protection:</b> (Radiation Protection Program with ALARA provisions; external and internal dosimetry; exposure evaluations; dose and survey records and reports; annual notifications to workers; bulletins and other generic communications)</p>		
9	<p><b>Radioactive Waste Management:</b> (Disposal; effluent pathways and control; storage areas; transfer packaging, control, and tracking procedures; equipments; incinerators, hoods, vents, and compactors; license conditions for special disposal method)</p>		
10	<p><b>Decommissioning:</b> (Record relevant to decommissioning; decommissioning plan/schedule; notification requirements; cost estimates; funding methods; financial assurance; and Timeless Rule requirements; changes in radiological conditions since decommissioning plan was submitted)</p>		
11	<p><b>Transportation:</b> (Quantities and types of licensed material shipped; packaging design requirements; shipping papers; hazardous materials (HAZMAT) communication procedures; return of sources; procedures for monitoring)</p>		

	radiation and contamination level of packages; HAZMAT training; and records and reports)		
12	<b>Notifications and Reports:</b> (Reporting and follow-up of theft, loss, incidents and overexposures. Notification of change is RSO and/or authorized user. Radiation exposure reports provided to individuals)		
13	<b>Posting and Labeling:</b> (Notices; license documents; regulations; bulletins and generic information; posting of radiation areas; and labeling of containers of licensed material)		
14	<b>Independent and Confirmatory Measurements:</b> (Areas surveyed; both restricted and unrestricted, and measurements made; comparison of data with staff's results and regulations)		
15	<b>Audit Findings:</b>		

Review completed by: J. Marvin Pratt, Radiation Safety Officer

Signature: \_\_\_\_\_ Date: \_\_\_\_\_

Department of Environmental Health &amp; Safety

**Pregnant Worker Declaration**


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 PRENATAL RADIATION EXPOSURE RISKS AND PRECAUTIONS
 

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I have received information regarding the risks of prenatal radiation exposure to the developing embryo/fetus, the limits for such exposure and the California State University, Chico policy and options available to me to maintain such exposures as low as reasonably achievable (ALARA).

If I wish to continue working with and/or around radiation sources while I am pregnant, I understand that University's policy encourages me:

- (1) To become a declared pregnant woman by notifying the Radiation Safety Officer, in writing, of my pregnancy and the estimated date of conception.
- (2) To consult with EHS as early as possible to discuss any particular concerns which I may have regarding this issue.

Please sign below and print in ink.

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 (My Signature)

---

 (Date of Signature)

---

 (My Full Legal Name)

---

 (Department)

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 (Responsible Principal Investigator)

Please return this form to the Radiation Safety Officer in the Department of Environmental Health and Safety, at zip 019

## ATTACHMENT 6

## SECTION 16.6



Department of Environmental Health &amp; Safety

**Transfer of Radioactive Materials (Internal)**

Name: \_\_\_\_\_

Date:

\_\_\_\_\_

Department:

\_\_\_\_\_

Storage location (current):

\_\_\_\_\_

Radionuclide(s)			
Millicurie			
Volume			
Physical Form			

Transferred to: \_\_\_\_\_ (Authorized User)

Signature<sup>1</sup>: \_\_\_\_\_

Transferred by: \_\_\_\_\_ (Authorized User)

Signature<sup>1</sup>: \_\_\_\_\_

Comments:

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Received by EHS: \_\_\_\_\_

<sup>1</sup>: Signature indicates the recipient certifies their current authorization allows the possession of the radionuclide(s) in the amount and form being transferred.

**SUBMIT:** Original to EHS at zip - 019  
Copy to Originator  
Copy to Recipient of materials