RADIATION SAFETY MANUAL

Radiation Safety Office

California State University Long Beach

June 2018

In Case of Emergency, contact:

- Radiation Safety Office (562.985.5623) during working hours or,
- University Police (911)

http://www.csulb.edu/cnsm/radation

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I. INTRODUCTION

The California Department of Public Health, 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 Academic B license to this campus which grants the California State University Long Beach (**CSULB**) the authority to possess radioisotopes and issue specific radioisotope-use permits called ionizing radiation use authorizations (**IRUA**s) to qualified CSULB faculty and staff. Persons granted such authorizations are termed "Authorized Users" or simply "Users". A presidentially appointed Radiation Safety Committee (**RSC**) issues IRUAs and manages the radiation safety program at CSULB.

This Radiation Safety Manual has been established to inform both the RHB and CSULB personnel of campus policies controlling sources of ionizing radiation, and requirements regarding IRUA acquisition and retention. Possession of a valid IRUA is a privilege. Any single IRUA holder's actions can affect the entire CSULB license. For that reason, strict adherence to the provisions of this manual and the User's IRUA 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 which will protect health, eliminate danger to life and property and comply with relevant State and Federal regulations.

II. UNIVERSITY LICENSE

The University has been issued a Broad Scope Academic B license from the California Department of Public Health, Radiologic Health Branch (RHB). Copies of this license are available for inspection at the CSULB Radiation Safety Office.

III. DESCRIPTION OF THE CAMPUS RADIATION SAFETY PROGRAM

A. Role of the University President

The RHB considers the President of CSULB ultimately responsible for the safe use of all regulated radioactive materials and radiation-producing machines on campus. The president has the power to appoint members of the Radiation Safety Committee (RSC). The president may delegate functional responsibility to a qualified manager/administrator on campus and has formally delegated administrative oversight for the radiation safety program to the Dean of the College of Natural Sciences and Mathematics (CNSM).

B. Radiation Safety Manual

The Radiation Safety Manual serves as a guide for individuals using or having responsibility for the use of radioactive materials or radiation sources, and contains the campus policy, organization, operating procedures and standards for the radiation safety program. Key word searches on the web version is usually the quickest way to look up an issue. Bookmark this website:

- http://web.csulb.edu/colleges/cnsm/radiation

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 Title 17 (17 CCR) and in the Code of Federal Regulations Title 10 part 20 (10 CFR 20). The Manual reflects commitments made to the RHB in the license application and as such must be strictly followed. Both the regulations and the Campus License are available for review in the Radiation Safety Office.

C. Radiation Safety Committee (RSC)

The RSC is responsible for advising the President or designee(s) on all matters related to radiation protection; reviewing and subsequently approving/rejecting proposed uses of radiation and radionuclides; and generally ensuring that the radiation safety program is effective. Members, including the RSC chairperson, are appointed by the University President. The RSC chairperson is named on the campus radioactive materials license. The RSC is composed of Authorized Users, a CSULB administrative representative the RSO and/or alternate RSO. A majority vote is required in order to approve IRUAs or other business before the committee, thus ensuring that the type and quantity of radionuclides requested, the proposed use, and the experience of the personnel involved adequately comply with CSULB standards for radiation protection. The RSC shall meet at least quarterly 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 User applications, etc. A quorum, consisting of a majority of the membership and the RSO or alternate, shall be present for a meeting to commence. Annually, a comprehensive program review shall be performed by the RSO and presented to the RSC for review, discussion and action as appropriate. While not possessed under the conditions of the campus license, the RSC may intervene in the control of "exempt" or "General License" sources of radiation.

D. Radiation Safety Officer (RSO)

The RHB requires that the RSO and alternate RSO be radiation safety professionals. When these individuals are deemed as qualified by the RHB, they are specifically named on the campus license. The alternate RSO is authorized to perform all RSO duties. The RSO and alternate are assigned responsibility 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. Actions of the RSO are generally subject to review and approval by the RSC and program administrator. The RSO may delegate some tasks to appropriately trained individuals.

1. **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 RSC and program administrator. The RSO 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 an IRUA or amendment thereto is reviewed by the RSO and either handled directly or referred to the committee for further consideration. All IRUA actions are communicated to the RSC via the RSC chairperson.
2. **The RSO is responsible for the review of campus compliance** with State and campus policies on radiation protection and for informing the RSC and/or program administrator on matters related to radiation safety as appropriate.
3. **The RSO is authorized to stop any use of any source of ionizing radiation on the CSULB campus**, and impound any materials/equipment involved when it is determined that a significant breach of safety or of CSULB procedures or license conditions is taking place. RSO actions are subsequently open to review and modification by the RSC or program administrator.

E. Purchasing, Central Receiving, Property and Foundation

All persons must obtain RSO approval prior to bringing any radioactive materials or other radiation source onto campus, including donated items or items brought in for demonstration/free trial use. Orders for radioactive materials or radiation producing machines must be formally approved by the RSO. The CSULB Purchasing Department, Central Receiving, Property Office and Foundation Purchasing 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 has been 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. See section V. "Radioactive Materials Acquisition, Delivery, Custody and Inventory" and VI. "Radiation Producing Machines Acquisition, Delivery, Custody and Inventory" for additional information.

F. Deans, Department Chairpersons, etc.

Deans and/or Department Chairpersons must review each IRUA with respect to proposed personnel, locations and uses of radionuclides and radiation producing machines within their jurisdiction. Department approval of the IRUA or the acquisition/use of an x-ray unit or electron microscope signifies that the department will provide the resources necessary to control hazards, and will establish departmental policies as necessary to support compliance with applicable campus and governmental standards and regulations. IRUA applicants must obtain the signature of their appropriate Department Chairperson(s) and/or Dean in order to be issued an IRUA.

G. Responsibilities of the Authorized User

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

1. **Notifying the Radiation Safety Office,** and/or University Police of the **loss or theft of a radiation source, or unsafe conditions** beyond the control of the user, e.g. gross contamination, excessive exposure, suspected intake, etc.

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.).
3. **Keeping and/or submitting required records** for inspection at reasonable times by the RSO or government 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 User's supervision, with training for specific laboratory procedures documented as necessary.
4. **Ensuring that all personnel who frequent areas under her or his supervision receive the appropriate level of instruction in basic radiation safety**. Those allowed to handle radioactive material must successfully complete both CNSM Introductory Safety Training and the RSO-coordinated Introductory Radiation Safety Training for radioisotope workers. Users are solely responsible for instructing their radioisotope workers in the safe use of radioactive material in lab-specific operations.
5. **Ensuring that radioisotope use and storage is limited** to locations, protocols, nuclides, chemical/physical forms and amounts listed on the IRUA.
6. **Placing and maintaining required warning signs and labels** as appropriate on doors, refrigerators, freezers, incubators, equipment, tools, benches, waste containers etc.
7. **Enforcing the appropriate use of protective clothing and equipment**, survey meters, and dosimeters as specified in this manual, by the RSO/RSC and IRUA conditions.
8. **Preparing radioactive wastes for disposal** in accordance with approved procedures, properly labeling the waste and filling out waste logs as appropriate. See Section VIII. B. "Labeling" and Section XV. "Disposal of Radioactive Waste" for additional information.

H. Responsibilities of the Radiation Worker

Each person who works with a source of ionizing radiation is responsible for keeping radiation exposures to themselves and others "As Low As Reasonably Achievable" (**ALARA**); for knowing and observing all appropriate radiation safety precautions; for working within the provisions of the IRUA; and for informing the Responsible User or RSO of any unsafe conditions.

IV. AUTHORIZATION TO USE IONIZING RADIATION

A. Radioactive Material IRUAs

1. Applications for Research, Classroom, Animal and Human Use

a) *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 User projects, directed student projects, graduate projects, etc.

b) *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.

c) *Animal Use*- Applicants requesting permission to administer radioactive materials to animals should consider the following:

   i) 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. Users who plan to work with live vertebrates must submit the appropriate application to the CSULB Institutional Animal Care and Use Committee well in advance of their intended start date. Approval by both the Radiation Safety Committee and Institutional Animal Care and Use Committee is required before animals are administered radioactive materials.

   ii) Radioactive excreta, animal carcasses and tissues, contaminated cage bedding, etc., must be handled as "Radioactive Animal Waste" in accordance with current CSULB radioactive waste disposal procedures, and with any additional stipulations from the RSO/RSC and waste broker/disposal site.

   iii) Users are responsible for ensuring that animal caretakers and custodians are aware of potential hazards and are adequately trained and supervised.

d) *Human Use*- The administration of radioisotopes, internally or externally, to humans is not permitted on this campus. The Student Health Center and the Kinesiology bone densitometry lab are the only campus entities authorized to administer ionizing radiation (in the form of diagnostic x-rays) to humans.

2. Procedure for Obtaining an Ionizing Radiation Use Authorization (IRUA)

a) *Submittal of Application*- In order to become an Authorized User for projects involving the receipt, possession and/or use of CSULB-license controlled radioactive materials, an "Application for Ionizing Radiation Use Authorization" and a "Statement of Training and Experience" form must be submitted to the RSC via the RSO. IRUAs are granted only to University or Foundation employees. The applicant must have accrued a minimum of 20 hours of training and/or experience in radiation safety and safe handling techniques. An IRUA cannot be transferred and is required without regard as to whether the items are procured by purchase, loan, gift or previous ownership. IRUA application packets are available in the Radiation Safety Office. Some application forms are on the CSULB Radiation Safety website.

b) IRUA Application Review Process

i) The RSO first reviews all applications to ensure that all safety issues have been adequately addressed. The following key parameters will be considered by the RSO and RSC:

ii) applicant training and experience;

iii) training and experience of project personnel;

iv) the nature of the requested facility(ies);

v) adjacent facility uses;

vi) radiation hazards and chemical toxicity of requested materials;

vii) amount and concentration of radioactive materials;

viii) past radiation safety findings;

ix) input from responsible interested parties;

x) frequency of use;

xi) Waste streams.

b) *Signature and Distribution Requirements*- If the RSC approves the IRUA application, the IRUA document is then sent to the responsible User for her/his signature, which verifies that she/he will abide by the requirements set forth in the IRUA. The signatures of the Department Chair and the Chair of the RSC must also be obtained, after which the IRUA is signed by the RSO. An IRUA for radioactive materials is typically approved for a period of one year (materials) or five years (machines). Copies of the completed IRUA are distributed as follows:

i) Original retained by the RSO.

ii) Copy 1 issued to the Responsible User.

3. Procedure for IRUA Renewal

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. IRUAs must be renewed if:

i) work with licensed radioactive materials is to continue; or

ii) any licensed radioactive materials are to remain in possession of the User.

b) I*ssues considered by the RSO/RSC during the renewal review process* will include the following:

i) changes in the scope, location or procedures of the project;

ii) past compliance with pertinent regulations; and

iii) changes in the type or quantity of radioactive materials authorized.

4. Procedure for Amending an IRUA

Proposed changes in use locations, radionuclides, etc. require an IRUA amendment. Requests to amend an IRUA must be submitted well in advance to the RSO, who will review the request or forward it to the RSC and Department Chair for review if necessary. Changes in use-location usually require approval from the appropriate administrator. Use of licensed radioactive materials off campus is not permitted.

5. Procedure for Terminating an IRUA (Closure)

a) *An IRUA will expire if not renewed, and may be terminated prior to the stated expiration date* if the responsible User is found to be willfully or negligently in violation of the University regulations or governmental regulations. Upon termination, all radioactive work must stop and all radioactive materials are subject to impoundment by the RSO. RSO action is subject to review and modification by the RSC. The IRUA will normally be terminated prior to the expiration date upon completion of the Users' need for radioisotopes.

b) *A User terminating their IRUA must, with the approval of the RSO, ensure* that all unused radioactive material is transferred to another active IRUA, placed in appropriate storage, or disposed of as radioactive waste. The User 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 indicating that all areas listed on the User's IRUA are free from contamination. Radiation Safety will undertake confirmatory contamination surveys. The User must then remove all warning signs, labels etc., after which the RSO may the area(s) for unrestricted use, such that the area is no longer under the jurisdiction of the Radiation Safety Program.

B. Radiation Producing Machine IRUAs: Non-Medical

The CSULB RSC issues an IRUA to the primary User of each non-medical x-ray machine. The RSO registers each operable electron microscope and radiation producing machine with the State RHB as required. X-Ray training for machine supervisors and operators is required and must be completed before using any radiation producing machine. Other requirements such as area posting, radiation surveys, training documentation etc. must also be completed before use. These devices are regulated by the RHB but are not addressed under the terms of the campus Radioactive Materials License. See the CSULB Radiation Safety Office for more information.

C. Radiation Producing Machine IRUAs: Medical

Medical diagnostic X-Ray machines are registered with the RHB with the assistance of the Radiation Safety Office. All other issues of radiation safety and regulatory compliance within Student Health Services are managed by the facility's supervising physician; assistance/support from the RSO/RSC is available upon request. Annual compliance checks are performed by radiation safety personnel. These devices are registered and regulated by the RHB but are not addressed under the terms of the campus Radioactive Materials License.

D. Conditions Requiring an Amendment to the CSULB License

Proposals for the use of radioactive materials involving any of the three conditions listed below will require submittal to the state RHB of a radioactive materials license amendment request. A written justification must be submitted by the Authorized User to the RSC and a detailed safety protocol will also be required.

a) Use of radionuclides not specifically included in the campus license.
b) Quantities of radionuclides in excess of the campus license limits.
c) Use of licensed radioactive material at an off campus locations.

The license amendment must be obtained from the RHB prior to acquisition of the material or implementation of the new procedure or location. Since this amendment process typically takes many weeks, Users are encouraged to contact the RSO well in advance of the need. License fee increases may be associated with a license amendment which could be passed on to the Authorized User.

V. RADIOACTIVE MATERIALS ACQUISITION, DELIVER, CUSTODY, AND INVENTORY

A. Acquisition of Radioactive Material

1. Shipment Approval

Each shipment of radioactive materials to CSULB must be approved by the RSO. RSO approval is contingent upon the following:

a) The requested radionuclide and form is authorized by the User's IRUA and campus license;

b) The amount requisitioned, when added to the User's current inventory does not exceed the total authorized by the IRUA or the campus license.

2. RHB-Regulated Radioactive Materials

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), and the amount in appropriate units (mCi, µCi, or Bq.);

c) the name of the CSULB Authorized User making the request;

d) the chemical and physical form of the radioactive material; and

3. Purchasing

1. The Purchasing Department or Property Office (State and Foundation) have been instructed to alert the RSO of requests to purchase, or to have delivered, radioactive materials.

B. Delivery of Radioactive Material

The campus Receiving Department personnel are trained to handle radioactive material packages following an established procedure. They have a dedicated holding area for such packages and alert the RSO when such a package arrives. The packages are picked up by the RSO or trained designee and processed per the Standard Operating Procedure. IRUA holders are to notify the Radiation Safety Office immediately in the event of any radioactive material delivery made directly to them so that appropriate package processing can be done. For standard processing, the RSO/designee then retrieves the package and takes it to the Radiation Safety support lab, HSCI-018A. Packages of radioactive materials will not be transferred to the responsible User until the RSO or trained designee has executed the RHB-approved radioactive package receipt procedure. **Each order of radioactive material must be shipped to the attention of the RSO to ensure proper processing. Send orders to:**

Attn: Radiation Safety Officer
1331 Palo Verde Ave.
Long Beach, CA 90840

C. Custody of Radioactive Material

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

D. Inventory of Radioactive Material

The RSO shall be responsible for keeping master inventory records of all licensed radioactive materials. The RSO shall send all Users a form, "Summary of Inventory of Sealed and Unsealed Sources" four times per year, to be completed and returned in a timely fashion.

VI. Radiation-Producing Machine (X-Ray Units and Electron Microscopes) Acquisition, Delivery, Custody, and Inventory

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. These machines must be registered with the State Radiologic Health Branch within 30 days of acquisition. Failure to register the machine and establish appropriate safety measures is a violation of State law. See the CSULB Radiation Safety Office for more information.

VII. SHIPMENT OF RADIOACTIVE MATERIALS *FROM* CSULB

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

VIII. SECURITY, LABELING, AND POSTING OF RADIOACTIVE MATERIALS/AREAS

A. Security: Loss and Theft Prevention

Regulated radioactive materials shall be stored in a manner that prevents unauthorized removal. 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. Challenge anyone you do not recognize that enters or attempts to enter the lab. Report suspicious persons or conditions to University Police. Inform the RSO of any theft or loss of radioactive material.

B. Labeling: Containers and Work Areas

All containers holding radioactive materials for storage, processing or use, shall be conspicuously labeled with the standard radioactive material trefoil. Labels shall include the identity of the User or lab worker, radioisotope present, maximum activity in microCuries, milliCuries or Bequerels, 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. Radioactive materials work areas shall be delineated with yellow vinyl tape, supplied by RSO, and labeled with radioactive materials stickers. Labels shall include name, date, isotope and amount. Users may indicate quantities not to exceed by using the ≤ symbol. For example, if you know that you will never work with quantities of radioisotope greater than 100 µCi, you may write ≤ 100 µCi for the quantity used.

C. Posting: Rooms, Equipment and Storage Units

1. 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 trefoil. 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/hr or 0.05mSv/hr) must also be properly posted.

2. Notice to Employees

State Form RH 2364 "Notice to Employees" is permanently and conspicuously posted on the official bulletin board on the 100 level Hall of Science. It is also posted in radioisotope use areas. Users and workers should be familiar with its content.

IX. RADIATION SAFETY TRAINING REQUIREMENTS – INTRODUCTORY

A. Radioisotope workers

Introductory laboratory safety training is a prerequisite for radiation safety training. Those who plan to work with radioisotope are required to complete an introductory radiation safety training process that consists of a training session conducted by Radiation Safety personnel combined with hands-on demonstrations and exercises. See the Appendix section for the content of this radioisotope worker training. Following the training session each trainee must complete a study regimen and complete a radiation safety worksheet. If the worksheet was done correctly, trainees take an exam. The exams are graded and the results shared with the trainee. Any missed questions are explained. Those who do not get a passing exam score of at least 90% are sent to study further and re-test. Those who pass have their training status documented by various means including hard copy signature which is maintained at the Radiation Safety Office.

B. Other Lab Personnel Who Do Not Handle Radioactive Material

These people, all having completed Introductory Safety Training, are informed of what isotopes are present, how to survey for contamination/exposure with the proper meter, where the material is used and stored, the location of the RHB 2364 poster, and the prohibition of touching anything radioactive as well as other safety related restrictions. This level of training is documented in User records and each quarterly inspection Radiation Safety personnel check to confirm this level of training has been performed and documented.

C. Awareness Training for Ancillary Personnel

Campus police, Facilities Management workers, custodians and outside contractors who may enter radioisotope areas without a knowledgeable escort to oversee their work for safety compliance are provided with an awareness level of general and radiation-specific safety training. This training is provided face-to-face upon first working in our areas. Refresher training sessions are conducted regularly.

X. REFRESHER RADIATION SAFETY TRAINING

A. Authorized Users

Authorized Users and their project personnel are required to personally participate in two hours of refresher radiation safety training activity per year. This training may be either live, videotaped or consist of a written exercise etc. and will be coordinated by the RSO. Refresher training will be 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, spill cleanup, biological effects, radiation physics, environmental issues, ALARA techniques, radiation detection equipment, recordkeeping, and training tips for project workers. Authorized Users are responsible for project specific safety training for persons affected by their program. Users are also responsible for implementing, and communicating to all appropriate personnel, any new policies or procedures instituted by the Radiation Safety Office.

B. Ancillary Personnel

Supervisors and/or training coordinators with Facilities Management and University Police coordinate introductory and refresher training for their workers. Radiation safety issues are addressed. Those already trained may train others. RS personnel will make the presentation upon request.

XI. BASIC RADIATION SAFETY RULES

A. Keep All Radiation Exposures As Low As Reasonably Achievable (ALARA)

What ALARA means, is that even if your exposure is below regulatory limits, you are still obligated to take all reasonable steps to reduce your exposure further. All work areas should be at background level with any areas of elevated exposure shielded and isolated from occupied areas.

B. 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 field by measuring the highest radiation rate and factoring in the expected time of exposure. Individual labs usually have detection meters that measure “counts per minute” (CPM). Contact the RSO for a quantitative survey in mR per hour using an appropriate dose rate meter.

External radiation exposure from a given radioactive source is controlled by keeping three factors in mind: ***TIME, DISTANCE and SHIELDING.***

1. Decrease Time Exposure

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 provide a good estimate of the expected exposure time.

2. Increase Distance

Increasing the DISTANCE from the source is frequently the most effective and economical means to reduce radiation exposure from gamma rays and other penetrating radiations. A radiation field is inversely proportional to the square of the distance to the source. 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 by dissuading personnel from lingering in these areas.

3. Shielding

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 in front of the radiation source:

a. *Gamma radiation* is best shielded by using appropriate amounts of dense materials, typically lead bricks, lead sheets, leaded glass/acrylic, 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 32P beta emissions can produce penetrating x rays called Bremsstrahlung when shielded by lead, steel or other dense metals. Less dense materials such as plastic or plexiglass should be used for shielding 32P whenever possible. Radiation Safety stocks many beta shields and issues them as needed. 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 from fresh stock bottles of 32P.

C. Eliminate the Potential for Internal Exposure

Incorporation of radioactive material into the body by inhalation, skin absorption, or ingestion or injection (from puncture or wound entry) is easily prevented by following the radiation protection rules listed below. Inhalation of radioactive material can be prevented by using a properly functioning chemical fume hood when handling volatile or aerosolized radioisotope solutions, or when handling large quantities of non-volatile, unsealed radioactive materials. Follow the standard radiation protection practice guidelines as appropriate to preclude ingestion, inhalation or absorption. Read the Nuclide Safety Data Sheet (found in your Radiation Safety Notebook) before beginning work with that nuclide.

1. Keep the **appropriate survey meter ON and the sound ON** when using radioisotopes other than 3H. Frequently check gloves, work areas, equipment etc. for contamination. Every time you use a survey meter, first turn switch to "bat" to make sure the battery is good, then check meter function with a radiation source to confirm it's working properly. Confirm it has been calibrated within one year by examining the calibration sticker on side of unit. Personal dosimeters may be issued to quantify exposure when higher energy radiation sources are used. If issued to you, WEAR YOUR DOSIMETER(s) and always orient dosimeters to receive the maximum dose you are exposed to during the procedure. Do not take contaminated garments out of the lab; discard them as radioactive waste or bag and label them, then notify the RSO. The RSO can store bagged coats for decay to background (short ½ life nuclides only).
2. Wear **lab coats and impermeable gloves** when working with radioactive material. Avoid exposure from contamination by changing gloves as frequently as needed. Double gloves are sometimes a good idea. Never keep wearing known-contaminated gloves or lab coat. Additional protective equipment and/or garments, commensurate with the hazard potential, may be specified by the RSO/RSC and shall be used.
3. Wear **fully enclosed chemical splash goggles** if splash to the eye is possible when working with radioactive liquids.
4. Keep **radioactive solutions and waste in capped or otherwise sealed containers** when not in immediate use.
5. Work with radioactive material in a **properly operating chemical fume hood** when necessary. Confirm the hood has been checked by safety within the past year and the airflow indicator shows proper operation.
6. Store and transport containers of **radioactive solutions in secondary containment trays**, buckets or on liquid-tight carts.
7. Line trays and working surfaces with **absorbent paper or foil** as appropriate. Absorbent bench coat paper with plastic backing is best; always place absorbent side UP.
8. **Clearly label containers of radioactive material** and post all radioisotope use/storage areas with the standard radiation warnings. Radiation Safety will provide pre-printed caution labels upon request. The RSO will label a designated sink for washing contaminated lab ware if necessary.
9. Conduct work with radioactive materials **in accordance with the User's IRUA**, and with the appropriate **supplemental written radiation safety and operating procedures**.

10. **Perform "dry runs"** of new procedures with non-radioactive items before using isotope.
11. **Survey work areas** after handling radioactive materials and document post experimental surveys.
12. **Isolate, then clean up spills promptly.** Refer to the spill cleanup poster for guidance.
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.
14. **Do not pipette by mouth.**
15. **Do not handle your wireless devices** while working with radioisotope. You may contaminate the device and subsequently contaminate your hands, skin or face.

XII. EVALUATION OF INTERNAL AND EXTERNAL DOSE

A. External Exposure from Radioactive Materials or X-Ray Devices

External exposure to radiation can come from many sources. It is the combined role of the Radiation Safety Office, Authorized User and trained workers to keep exposure to ionizing radiation by workers, students and the public as low as reasonably achievable. The institution is obligated to notify workers and the public of sources of radiation by area postings and training and to maintain exposure to levels ALARA.

1. Occupational Exposure

Radiation Safety Office personnel will monitor occupational exposures to radiation, and issue dosimeters in accordance with 10 CFR 20.1502(a).

2. Personnel Exposure Data

Personnel exposure data will be a part of the permanent records of the Radiation Safety Office. All radiation workers have access to her/his own dosimetry records and the records of their co-workers. Dosimetry reports will be posted for review in the Radiation Safety Office. Badged personnel are encouraged to review their exposure and initial these reports. Any exposure over 100 millirem (1 mSv) or 25 millirem (0.25 mSv) for declared pregnant women or minors will trigger an investigation by the RSO and 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 records. These reports may also be provided to other employers. 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.

B. Internal Exposure from Unsealed Radioactive Materials

Internal exposure to radiation should be avoided to the extent possible. Radiation workers are trained in methods to eliminate the potential for internal exposure. Work practices and engineering controls are put in place to further reduce the potential for internal exposure. If internal exposure is suspected, a worker should immediately contact their supervisor and Radiation Safety so an initial assessment can be made.

1. Bioassay Policy, General

Bioassays are tests designed to help quantify the dose received from ingested, inhaled or absorbed radioactive material. Most bioassays involve analyzing urine specimens for radioisotope content. Radioiodine bioassays measure thyroid uptake. CSULB does not maintain a stand-alone bioassay program. Almost invariably, experimental quantities of unsealed radioactive materials are in non-volatile aqueous form and below 10% of the ALI. In the past three decades, with many more users and higher experimental activity limits in the past, no known intake has occurred. Should, in the wake of an accident, an intake be known or suspected, the individual would be referred for bioassay at a sister institution that has a RHB-approved bioassay program in place. The results of any such bioassay will be shared with the individual and the documentation will be retained in the dosimetry files of the CSULB RSO. This internal dosimetry information will be provided to other employers in conformance with 17 CCR 30255(b)(6) and 10 CFR 20.2104.

C. Radiation Surveys for Radiation Levels and Contamination

1. User Radiation Monitoring Responsibilities

a) Users are responsible for ensuring that radioisotope work areas listed on their IRUAs are in compliance with State limits regarding radiation fields and worker exposures, and that all work is performed in accordance with the campus ALARA policy. Surveys and decontamination activities must be performed by qualified persons who are current with respect to radiation worker level safety training.

b) Each 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 Office. The survey meter audio must be on at all times.

c) Documented radiation level surveys and/or contamination checks as appropriate shall be performed after each experiment and at least monthly in areas where unsealed radioisotopes are handled/stored.

2. Radiation Exposure Levels

See Section XI (C) (1) – Basic Radiation Safety Rules and the nuclide-specific Safety Data Sheets in the Appendix section of this manual for instructions on performing surveys. User survey meters are designed to detect low levels of contamination. When all possible ALARA measures have been taken and a high radiation field is still present, notify the RSO. The RSO will measure the field with a calibrated instrument that indicates mR/hr. The RSO will work with lab personnel to further reduce radiation levels. In the event the field cannot be reduced to below 5.0 mR/hr at one meter from the source, the location will be posted with a “Radiation Area” sign.

3. Contamination Levels

There are two characteristics of contamination; Removable and Fixed.

Removable contamination is activity that can be released from a contaminated surface and detected with instrumentation. It poses a threat of contaminating other things and accidently contaminating people, which can lead to an internal dose. Whenever possible, removable contamination should be scrubbed clean. If an item is dedicated only to radioisotope use and is difficult to clean, it may be labeled as contaminated and still used by gloved personnel. Care should be taken not to spread contamination. The Radiation Safety Officer considers an item clean if contamination levels are below 200 DPM per 100 cm2 removable activity limit and a 0.1 mR/hr or less direct reading. The RSO may require more stringent cleaning such that post-cleaning swipe surveys are comparable to that of background. Background readings will be established by swiping (for LSC) or taking direct readings of known clean areas and recording these values as a reference.

Fixed contamination is what is left after swipe tests reveal no further contamination is removable from a surface. Rough or irregular surfaces can trap significant activity. Items contaminated with fixed activity must be labeled in the standard fashion and may still be used. Warning: Abrasion or chemicals can cause the formerly fixed contamination to become removable. Periodic wipe tests on known fixed contaminated surfaces is prudent.

XIII. RADIATION SAFETY PROGRAM AUDITS

In order to monitor compliance with safety principles and rules, the RSO/designee shall periodically perform comprehensive audits of Users' radioisotope programs. Audit frequency (two to four times per year) shall be determined 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 Appendix section of this manual.

XIV. CALIBRATION OF COUNTING/SURVEY EQUIPMENT

A. Portable Equipment

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

B. Liquid Scintillation Counter

The liquid scintillation counter (LSC) used by Radiation Safety remains under service contract with Southern California Scientific. Preventative maintenance is performed annually on the Liquid Scintillation Counter. CSULB commits to keeping this instrument under service contract with Southern California Scientific or an equivalent company and performing quarterly performance verification with factory standards.

XV. DISPOSAL OF RADIOACTIVE WASTE

A. Collection and Storage Areas

Central collection and storage areas for radioactive waste are under the exclusive control of Radiation Safety Office personnel. The RSO/designee will be responsible for packaging/handling of radioactive waste for off campus shipment, but individual generators of radioactive waste 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).

B. Radioactive Waste Types

Never mix the following waste types. Each waste type has its own designated container and a corresponding waste log sheet. You MUST log your radioactive waste in microCurie (µCi) amounts (do not use the symbol "<") on the correct log sheet before you leave the lab. Each different radioisotope in the waste must be given a separate entry on the log. Call Radiation Safety at x55623 for a waste pick-up when the container is 4/5 full. Sum the µCi quantity for EACH nuclide on the log-sheet before calling the Radiation Safety Office.

1. Dry Solid Short ½ Life (<90 days)

YELLOW LOG SHEET
This includes 32P, 33P, 35S, 125I. No liquids, lead or other chemical or biohazardous materials are permitted in this waste. NO SHARP ITEMS ARE PERMITTED (like pasture pipettes or broken glass). Sharp items must be put in a rigid closed container of some type (NOT wrapped in benchcote) before placing in the waste drum. **Keep container closed except when adding waste. Minimize volume. No rad stickers or labels.**

2. Dry Solid Long ½ Life (>90 days)

PINK LOG SHEET
This includes all other nuclides including, but not limited to, 3H, 14C, 109Cd. No liquids, lead or other chemical or biohazardous materials are permitted in this waste. NO SHARP ITEMS ARE PERMITTED (like pasture pipettes or broken glass). Sharp items must be put in a rigid closed container of some type (NOT bench coat) before placing in the waste drum. **Keep container closed except when adding waste. Minimize volume. No rad stickers or labels.**

3. Aqueous Liquid (mixed ½ lives OK)

GREEN LOG SHEET
This waste consists of water-based solutions and harmless contaminated materials such as detergents, dilute alcohol, dilute acetic acid, buffers and non-hazardous solutions etc. pH must be between 6 and 11. It is collected typically in a plastic bottle placed in a containment tray. Check with Radiation Safety Office before adding anything but water-based, biodegradable solutions to this waste-stream. **Keep container closed except when adding waste. Do not fill more than 80% full** – leave some space.

4. LSC Vials (Mixed ½ lives OK)

BLUE LOG SHEET
This waste consists of tightly-capped scintillation vials containing LSC cocktail plus samples. These vials are

usually stored upright in the original crates. Make sure vials are tightly closed before calling for waste pickup. Radiation Safety Office personnel can provide crates.

5. Mixed Waste—Long Half-Life

ORANGE LOG SHEET ***RSO approval is required prior to generating this waste.***
This waste type consists of regulated liquid hazardous waste mixed with long half-life radioactive waste. Common regulated hazardous waste includes diethyl ether, methylene chloride, methanol and other solvents, heavy metals, acids or other toxic materials. Upon approval, Radiation Safety Office personnel will confirm the chemical compatibility of the components and the material required for the container. Double containment is required – Radiation Safety personnel can provide trays. **Keep container closed except when adding waste. Do not fill more than 80% full** – leave some space.

6. Mixed Waste—Short Half-Life

WHITE LOG SHEET ***RSO approval is required prior to generating this waste.***
This waste type consists of regulated liquid hazardous waste mixed with short half-life radioactive waste, including ^{32}P, ^{33}P, ^{35}S, ^{125}I. Common regulated hazardous waste includes diethyl ether, methylene chloride, methanol and other solvents, heavy metals, acids or other toxic materials. Upon approval, Radiation Safety personnel will confirm the chemical compatibility of the components and the material required for the container. Double containment is required – Radiation Safety personnel can provide trays. **Keep container closed except when adding waste. Do not fill more than 80% full** – leave some space.

7. Animal Waste

This waste type consists of carcasses, tissue, blood, excreta etc. ***Each project generating such waste and waste management plans must be pre-approved by the RSO.*** This material must usually be stored frozen or refrigerated.

8. Unusual Items

Sealed sources/foils, uranium, contaminated lead items, thorium and consumer products (smoke detectors, anti-static devices, radium dials, etc.) may not be put in any of the above waste containers. **Call the Radiation Safety Office.**

Please note: Permission from the RSO must be obtained prior to generating any waste that does not conform to the above descriptions. The RSO must be notified prior to generating unusually large volumes of waste material. Special procedures may require RSO and RSC approval.

XVII. RADIOACTIVE MATERIALS EMERGENCIES

A. Minor Spills of Radioactive Materials

Minor spills that involve no significant skin contamination or physical injuries, Proceed as follows:

- When performing cleanup activity, **wear protective clothing (PPE)** such as lab coats, gloves and shoe covers.
- **Survey the area** to determine the level and location of contamination.
- **Post the area** with appropriate temporary warning signs if necessary.
- **Mark off contaminated areas** with caution tape, chalk, grease pencil or felt marker.
- **Cover areas** as appropriate with paper or bench coat to prevent spread of contamination. When short half-life materials are involved, often placing a shield plate over the area until it decays away is the best course of action and is an ALARA measure reducing exposure from the spill.
- **Remove "hot" spots first**, *working from the perimeter toward the center to prevent spreading contamination.* Be aware that "run-off" or drips may spread contamination.
- **Dispose** of the moist contaminated paper towels in the "Dry Solid" waste and log it. If both long and short life nuclides are mixed in the spill/cleanup, dispose as long life waste.
- **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 soles of shoes.
- **Label, then 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.
- For assistance contact the RSO at 562.985.5623 or at 714.222.0963.
  Alternate RSO at 562.577.0504

An action level of 200 DPM per 100 cm2 removable activity limit and a 0.1 mR/hr or less direct reading is required for cleaning. The RSO may require more stringent cleaning such that post-cleaning swipe surveys are comparable to that of background. Background readings will be established by swiping (for LSC) or taking direct readings of known clean areas and recording these values as a reference.

B. MAJOR Radioactive Material Spills or Contamination Events

CONTACT THE RSO USING THE NUMBERS ABOVE OR UNIVERSITY POLICE 911. The State Radiologic Health/Emergency Services number is 800.852.7550.

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. Major incidents should be addressed as follows:

NOTE: IF THERE IS THE POTENTIAL FOR AIRBORNE RADIOACTIVE MATERIAL OR AIRBORNE CHEMICAL HAZARD (SUCH AS CHLOROFORM OR ETHER), IT IS NOT SAFE. EVACUATE THE AREA AND WAIT FOR EMERGENCY RESPONDERS.

DETERMINE RADIATION FIELD BEFORE RE-ENTERING AREA OF SPILL. IF SAFE to enter spill area, don appropriate PPE. A lab coat, goggles, protective gloves, booties and coveralls are recommended. PPE is stored in the "Safety Cabinets" in HSCI room 385 and MLSC 300 level lobby.

Cover liquid spills with absorbent paper and dry spills with dampened absorbent paper if safe to do so.

Do NOT GENERATE AEROSOLS OR CONTAMINATED PARTICULATES. Trained personnel equipped with respirators will respond if airborne contamination is suspected.

Survey shoes, lab coats, hands etc. before leaving the contaminated area. Remove and contain any contaminated clothing. If skin is contaminated, flush with large quantities of water. Use a catch basin or sink or floor drain when flushing if possible. Measure exposure levels. If the material spilled is causing high external radiation levels, move to an area of low dose rate. Post warnings and divert traffic around all contaminated or high exposure areas as appropriate. Begin decontamination as soon as is safely possible. Follow all instructions given by Radiation Safety personnel. Do not leave the area or return to routine project work until authorized by the RSO. Recall that if short half-life isotopes have been spilled, temporary shields can sometimes be placed over the spill thereby eliminating exposures and radioactive waste associated with a full cleanup.

C. Fires and/or Injuries Involving Radioactive Materials

Call 911 immediately or pick up an emergency phone which will ring directly to University Police. Be sure to mention the involvement of radioactive materials to the Dispatcher. Ask them to contact the RSO. When police arrive, describe location, amount and type of radioactive materials involved etc.

APPENDIX - POLICIES, PROCEDURES, GUIDES

A. Conversion Formulas/Dose Information

Conversions from Curies to Becquerels	Becquerel's (Bq) are the SI units of radioactivity. 1 Becquerel = 1 disintegration per second (dps). Curies (Ci) are the historical unit of measure for radioactivity, and are still commonly used. Commonly used conversions are: 37 MBq/mCi 27.03 µCi/MBq
Conversions from CPM to DPM	CPM's are counts per minute and are dependent upon the counting efficiency of the instrument you are using. CPM can be converted to DPM (disintegrations per minute) using the counting efficiency of the instrument. For example, if the counting efficiency of a meter is 20% for P-32 and it reads 100 CPM, it means that you are really measuring 500 DPM. DPM can then be converted to mCi or Bq as shown below.
More helpful units	1 millicurie (mCi) = 2.22 x 109 DPM 1 microcurie (uCi) = 2.22 x 106 DPM 1MBq = 6 x 107 DPM
Occupational Dose Limits (10CFR20) (Annual Limits)	*For adults:* Whole body: total effective dose equivalent: 5 rem (0.05 Sv) Lens of the eye: 15 rem (0.15 Sv) Skin or any extremity: 50 rem (0.5 Sv) *For minors and declared pregnant workers:* 1/10 the whole body dose

B. Contamination Survey Procedures

Contamination surveys are to be conducted after each experiment or operation where radioisotope is handled. Monthly contamination surveys are also required at research labs where radioisotopes are used, stored, or where radioactive waste is generated.

How to Do Surveys for ^{3}H, ^{14}C, ^{35}S, and ^{109}Cd

The procedure for post-experimental surveys for low energy isotopes is as follows:

1. Use the hand-held meter to find any hot spots. Use the meter with the cylindrical probe for ^{109}Cd ("window in" for lower background); use the meter with the FLAT or "pancake" probe for the other isotopes. Note: These meters cannot detect ^{3}H. If using ^{3}H, go directly to STEP 2.

   Check for contamination by S-L-O-W-L-Y passing the probe just above the spot/item you want to check. Look at the meter face to read Counts Per Minute (CPM). If you see a higher CPM than "background" (background is the CPM reading for a known clean spot) then you probably have contamination. When checking areas that have a high background (such as a fume hood where stocks are stored or in use), wipe the spot with filter paper and then move away from the area and survey the paper with the probe. Get close but do not allow the probe to touch the item you are surveying. Shield high background areas as appropriate.

2. Wipe at least 5 areas within the workspace with a piece of filter paper, add a "clean wipe" control vial, and count using the Liquid Scintillation Counter (LSC). Include wipes of known or suspected contaminated areas. Change gloves as necessary. Don't forget freezer handles, doorknobs, sink tops, counters, equipment etc. Clean areas with more counts than background; re-wipe and count.

3. Remove the print-out from the LSC and write which area swiped corresponds to which sample number. Also write who the User is for the locations. Convert raw CPM to DPM/100 cm^2, correcting for background. Correlate swipe data to locations identified on a map of your laboratory. If this is a post-experimental wipe test, place the printout, map and conversion sheet in your Radiation Safety notebook. If it is a monthly survey, turn in to the Radiation Safety Office.

Decontamination of your work areas to levels below the action level of 200 DPM per 100 cm2 removable activity limit and a 0.1 mR/hr or less direct reading must be achieved. The RSO may require more stringent cleaning such that post-cleaning swipe surveys are comparable to that of background. Background readings will be established by swiping (for LSC) or taking direct readings of known clean areas and recording these values as a reference.

How to Do Surveys for ^{32}P, ^{125}I or Other High Energy Isotopes

The procedure for post-experimental surveys for higher energy isotopes is as follows:

1. Use the hand-held meter to find any hot spots. Use the meter with the flat or "pancake" probe for ^{32}P, and the cylindrical probe for ^{125}I. Check for contamination by slowly passing the probe just above the spot/item you want to check. Look at the meter face to read Counts Per Minute (CPM). If you see a higher CPM than "background" (background is the CPM reading for a known clean spot) then you likely have contamination. When checking areas that have a high background (such as near a ^{32}P waste container) wipe the spot with filter paper and then move away from the area and survey the paper with the probe. Following the "Spill Cleanup Procedure" posted in your work area, clean any areas that have more counts than background, then re-survey.

2. Promptly write your name, areas surveyed, and the DPM per 100 cm^2 on the "Contamination Survey Log Sheet" found in the Radiation Safety Notebook. Clean any areas that are contaminated, then re-survey and log those results also. Keep cleaning the contaminated areas and logging your results until your measurements are the same as background unless the equipment location is dedicated to radioisotope work and clearly labeled as contaminated. If contaminated, indicate the level of contamination in DPM per 100 cm2.

Decontamination of your work areas to levels below the action level of 200 DPM per 100 cm^2 removable activity limit and a 0.1 mR/hr or less direct reading must be achieved. The RSO may require more stringent cleaning such that post-cleaning swipe surveys are comparable to that of background. Background readings will be established by swiping (for LSC) or taking direct readings of known clean areas and recording these values as a reference.

C. Reproductive Health Policy

Male or female, you should never work with a chemical or radioactive material without knowing how it may affect the reproductive system, and the length of time the material could remain in your body if ingested, inhaled or absorbed. The use of some agents should be stopped well in advance of conception. The following Regulatory Guide published by the U.S. Nuclear Regulatory Commission should be consulted by pregnant women, those who plan to become pregnant and other personnel, to help them make decisions regarding radiation exposure during pregnancy. U.S. NRC Regulatory Guide 8.13. Rev. 3. June,1999

Pregnant women and those who plan to become pregnant are strongly encouraged to consult their physician regarding the evaluation of workplace hazards as they relate to reproductive health and fertility. The physician should be provided with specific information regarding type of work, chemicals and radiologic agents used, standard operating procedures and be provided Safety Data Sheets for all chemicals and radioisotopes use.

If working with radioactive and/or other hazardous materials, you may find the following documents helpful, all available from CNSM Safety and on the web:

- U.S. NRC Regulatory Guide 8.29 – Instruction Concerning Risks from Occupational Radiation Exposure. Rev. 1. February, 1996
- U.S. NRC Regulatory Guide 8.36 - Radiation Dose to the Embryo/Fetus. July, 1992
- NIOSH Pocket Guide to Chemical Hazards, from the U.S. Department of Health and Human Services
- MSDS Search Engine

Please feel free to contact your supervisor, CNSM Science Safety Office or Campus Environmental Health and Safety with any further requests for information required by you or your physician regarding reproductive hazards in the workplace.

Conditions Requiring Individual Monitoring of External and Internal Occupational Dose

Licensees are required to monitor the occupational dose to a declared pregnant woman, using an individual monitoring device, if it is likely that the declared pregnant woman will receive, from external sources, a deep dose equivalent in excess of 0.1 rem (1 mSv). It is the policy of CSULB that all declared pregnant women working in areas where ionizing radiation is or may be present shall be issued an individual monitoring device for both the prospective mother and fetus.

In compliance with 10 CFR part 20, section 20.1208, "Dose equivalent to an embryo/fetus", the licensee shall ensure that the dose equivalent to the embryo/fetus during the entire pregnancy, due to the occupational exposure of a declared pregnant woman, does not exceed 0.5 rem (5 mSv).

CSULB will employ, where possible, administrative controls (e.g. reassignment of affected personnel to non-ionizing radiation work, minimizing hours exposed, etc.) to reduce or eliminate employee exposure prior to or in conjunction with monitoring.

While exposure to ionizing radiation by a radioisotope worker at CSULB is expected to be minimal, significant chemical exposures ARE possible. All are asked to be especially vigilant about chemical exposure from all routes of exposure when considering matters of family planning.

Authorized Radioisotope User Responsibility

It is the responsibility of each Authorized Radioisotope User to:

a) Ensure all personnel ever present alone in the lab are sent through Introductory Safety Training and either Awareness Level radiation Safety Training or full Radiation Worker Training. Radiation worker training includes discussion of this reproductive health document.

b) Ensure that lab personnel sign the appropriate training documentation forms in your white Radiation Safety Notebook to further document lab personnel training.

c) Encourage early disclosure of pregnancy (intent or fact) to the Radiation Safety Office. Assure the student/employee that this disclosure will remain confidential.

d) Notify the Radiation Safety Office immediately upon receiving information regarding a student/employee's declared intent, or confirmation of pregnancy. Pregnancy must be declared in writing for the fetal dosimetry program to be implemented.

e) Advise students/employees of their personal responsibilities with regard to limiting their exposure to radiation and toxic chemicals while pregnant (see below).

f) Review student/employee work assignments in order to reduce the potential of radiation and toxic chemical exposures and implement exposure reduction whenever possible.

Radiation Safety Office Responsibility

It is the responsibility of the Radiation Safety Office to:

a) Ensure that pregnant students/employees receive a monthly fetal dosimeter in addition to the quarterly whole body badge if she uses radioactive materials or works near radioactive materials. The student/employee must wear the fetal badge at waist level, beneath/behind any shielding employed.

b) Monitor the dose accumulated by the student/employee and the fetus. The dose to an embryo/fetus shall be determined according to 10 CFR part 20, section 20.1208[1], and the NRC Regulatory Guide 8.36, "Radiation Dose to the Embryo/Fetus"[2].

c) Work with the student/employee and the Authorized Radioisotope User to endeavor to reduce radiation exposure to background readings if any monthly dose exceeds 25 mrem (0.25 mSv). If the accumulated dose approaches a total of 500 mrem (5 mSv), or exceeds 300 mrem (3 mSv) within six months, transfer or leave from the area of exposure is mandatory.

Female Employee Responsibility

It is the responsibility of each female employee to:

Consider informing the Authorized Radioisotope User, Department Chair and/or the Radiation Safety Office of your intent, suspicion or confirmation of pregnancy. RSO personnel will determine whether radiation levels in your working areas are such that you might receive 0.5 rem (5 mSv) or more over the gestational period. You must decide whether the exposure you are receiving is sufficiently low to protect the fetus; you are welcome to review the literature the Radiation Safety Office has available on this topic. If you decide to continue working in these areas, you must work with your supervisor and RSO personnel to reduce your exposure by employing the use of shielding, increasing your distance from the radiation source and decreasing the amount of time you spend in the radiation field.

Please consider the following:

The National Council on Radiation Protection (NCRP) recommends a total dose equivalent limit of 0.5 rem (5 mSv) for the fetus. Once a pregnancy becomes known, exposure of the embryo/fetus shall be not greater than 50 mR (0.5 mSv) in any month. The total dose equivalent limit for the whole period of pregnancy is important for the limitation of the risk of cancer induction and of developmental anomalies, while the monthly limit is important to ensure that exposures of the embryo-fetus during particularly critical periods of organogenesis and development are adequately restricted. The United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) indicates that for doses smaller than 2 rem (0.02Sv) over the gestation period, the risk for defects is relatively small in relation to the natural incidence or probability, which is assumed to be of the order of 6×10^{-2} for anomalies of all kinds that may seriously affect health and viability of newborn children (NCRP Report No. 91; June 1987.)[3]

[1]Federal Register, Nuclear Regulatory Commission. *10 CFR Part 20, "Standards for Protection Against Radiation".* January 1993.

[2]U.S. Nuclear Regulatory Commission. *Regulatory Guide 8.36, "Radiation Dose to the Embryo/Fetus".* July 1992.

[3]National Council on Radiation Protection and Measurements. *NCRP Report No. 91, "Recommendations on Limits for Exposure to Ionizing Radiation".* June 1, 1987.

D. CSULB Radioactive Materials Program Audit

Authorized User: _____ Department: _____

Survey/Inspection Date: _____ Date Sent To Pi: _____ Date Audit Complete: _____

User Locations: _____

1. Required Survey Record Being Kept

Monthly contamination survey results available YES___ NA___ NO___ _____
Adequate post experimental contamination surveys performed YES___ NA___ NO___ _____

2. Training Documented (Theory, Biological Effects and Protection)

Proof of qualifications/training for personnel on file YES___ NA___ NO___ _____
Current list of authorized project workers YES___ NA___ NO___ _____

3. Required Reports Returned To Radiation Safety Office

Quarterly inventory report complete YES___ NA___ NO___ _____
Possession limits not exceeded YES___ NA___ NO___ _____

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4. Proper Labeling Of Radioactive Materials/Areas

Materials labeled with nuclide, amount, P.I., date YES___ NA___ NO___ _____
Benches, hood, sink, etc. posted/labeled as appropriate YES___ NA___ NO___ _____
Current Notice to Employees, Emergency Procedures posted YES___ NA___ NO___ _____

5. Radioactive Wastes Being Handled Properly

Waste log(s) being maintained YES___ NA___ NO___ _____
Wastes being properly stored and segregated YES___ NA___ NO___ _____

6. Proper Personal Protective Equipment Employed

Gloves, lab coats, other protection as needed YES___ NA___ NO___ _____
Appropriate shielding, tongs, etc. used as needed YES___ NA___ NO___ _____

7. Dosimetry and Survey Provisions

Dosimeters correctly being used as necessary YES___ NA___ NO___ _____
Proper survey instruments available, functioning, calibrated, etc. YES___ NA___ NO___ _____

8. Food Storage

No food/drink is present in radioisotope areas YES___ NA___ NO___ _____

9. Proper Lab Technique Employed

Absorbent paper/foil in use as needed YES___ NA___ NO___ _____
Correct pipetting, transfer, handling, etc. YES___ NA___ NO___ _____

10. Housekeeping

Storage areas hoods, cold rooms, freezers, adequately tidy YES___ NA___ NO___ _____

11. Security

Access to project area restricted as necessary YES___ NA___ NO___ _____
Refrigerators/storage units kept locked as necessary YES___ NA___ NO___ _____

12. Contamination/Exposure Levels

Removable contamination levels in compliance with ALARA YES___ NA___ NO___ _____
Ambient exposure levels in compliance with ALARA* YES___ NA___ NO___ _____

13. Chemical Issues

_____

_____

14. Other

_____

_____

*Meter used/calibration date: _____

Inspected By: _____

E. Radiation Safety Training for Authorized Users and Radiation Workers

The RSO or designated representative schedules radiation safety training for all Users and radiation workers prior to use and before working in the vicinity of radioactive materials. IRUA principal investigators are to notify potential new users or ancillary personnel of the required radiation safety training and to have them contact the Radiation Safety Office at 562 985-5623. Those who plan to handle radioisotope are required to complete an introductory radiation safety training process that consists of live instruction presented by radiation safety personnel followed by a 100 point exam. A passing score of ≥ 90% is required to complete radiation safety training. Training is documented with documentation maintained in the radiation safety office for inspection.

Training Topics

Radiation safety training shall include but is not be limited to the following:

1. Reproductive health policy
2. Regulatory Framework/Current regulations
3. License conditions
4. Identification of use areas
5. Duty to report unsafe conditions
6. Annual dose limits
7. What is Radiation?
8. Sources of Radiation and Potential hazards
9. ALARA
10. Units and calculations typical to radioisotope operations
11. Detection instrumentation
12. Radiation safety procedures
13. Dose and dosimetry
14. Program audits

F. Nuclide Safety Data Sheets

Pages to follow.

^3H	Nuclide Safety Data Sheet Hydrogen-3 [Tritium] **www.nchps.org**	^3H

I. PHYSICAL DATA

Radiation:	Beta (100% abundance)	
Energy:	Max.: 18.6 keV; Average: 5.7 keV	
Half-Life [T½] :	Physical T½:	12.3 years
	Biological T½:	10 - 12 days
	Effective T½:	10 - 12 days*

* Large liquid intake (3-4 liters/day) reduces effective T½ by a factor of 2+; ^3H is easily flushed from the body

Specific Activity:	9650 Ci/g [357 TBq/g] max.	
Beta Range:	Air:	6 mm [0.6 cm; 0.25 inches]
	Water:	0.006 mm [0.0006 cm; 3/10,000 inches]
	Solids/Tissue:	insignificant [No ^3H betas pass through the dead layer of skin]

II. RADIOLOGICAL DATA

Radiotoxicity[1]: Least radiotoxic of all nuclides; CEDE, ingestion or inhalation:
- Tritiated water: 1.73E-11 Sv/Bq (0.064 mrem/uCi) of ^3H intake
- Organic Compounds: 4.2E-11 Sv/Bq (0.16 mrem/uCi) of ^3H intake

Critical Organ: Body water or tissue

Exposure Routes: ingestion, inhalation, puncture, wound, skin contamination absorption

Radiological Hazard:
- External Exposure - None from weak ^3H beta
- Internal Exposure & Contamination - Primary concern

III. SHIELDING

None required - not an external radiation hazard

IV. DOSIMETRY MONITORING

Urine bioassay is the only readily available method to assess intake [for tritium, no intake = no dose] Be sure to provide a urine sample to Radiation Safety whenever your monthly ^3H use exceeds 100 mCi, or after any accident/incident in which an intake is suspected

V. DETECTION & MEASUREMENT

Liquid Scintillation Counting is the only readily available method for detecting ^3H

NOTE: PORTABLE SURVEY METERS WILL NOT DETECT LABORATORY QUANTITIES OF ^3H

VI. SPECIAL PRECAUTIONS

- Avoid skin contamination [absorption], ingestion, inhalation, & injection [all routes of intake]
- Many tritium compounds readily penetrate gloves and skin; handle such compounds remotely and wear double gloves, changing the outer pair at least every 20 minutes.
- While tritiated DNA precursors are considered more toxic that ^3H_2O, they are generally less volatile and hence do not normally present a greater hazard
- The inability of direct-reading instruments to detect tritium and the slight permeability of most material to [tritiated] water & hydrogen [tritium] facilitates undetected spread of contamination. Use extreme care in handling and storage [e.g. sealed double or multiple containment] to avoid contamination, especially with high specific activity compounds.

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[1] Federal Guidance Report No. 11 [Oak Ridge, TN; Oak Ridge National Laboratory, 1988], p. 122, 156; Radionuclide and Radiation Protection Data Handbook [Delacroix, et al; Radiation Protection Dosimetry, Kent, England: Nuclear Technology Publishing 1998], p. 19.

VII. GENERAL PRECAUTIONS

1. Maintain your occupational exposure to radiation As Low As Reasonably Achievable [ALARA].
2. Ensure all persons handling radioactive material are trained, registered, & listed on an approved protocol.
3. Review the nuclide characteristics on (reverse side) prior to working with that nuclide. Review the protocol(s) authorizing the procedure to be performed and follow any additional precautions in the protocol. Contact the responsible Principal Investigator to view the protocol information.
4. Plan experiments to minimize external exposure by reducing exposure time, using shielding and increasing your distance from the radiation source. Reduce internal and external radiation dose by monitoring the worker and the work area after each use of radioactive material, then promptly cleaning up any contamination discovered. Use the smallest amount of radioisotope possible so as to minimize radiation dose and radioactive waste.
5. Keep an accurate inventory of radioactive material, including records of all receipts, transfers & disposal. Perform and record regular lab surveys.
6. Provide for safe disposal of radioactive waste by following institutional Waste Handling & Disposal Procedures. Avoid generating mixed waste (combinations of radioactive, biological, and chemical waste). Note lab staff may not pour measurable quantities of radioactive material down the drain.
7. If there is a question regarding any aspect of the radiation safety program or radioactive material use, contact Radiation Safety.

VIII. LAB PRACTICES

1. Disposable gloves, lab coats, and safety glasses are the minimum PPE [Personal Protective Equipment] required when handling radioactive material. Remove & discard potentially contaminated PPE prior to leaving the area where radioactive material is used.
2. Clearly outline radioactive material use areas with tape bearing the legend "radioactive". Cover lab bench tops where radioactive material will be handled with plastic-backed absorbent paper; change this covering periodically and whenever it's contaminated. Alternatively cover benches with thick plastic sheeting (i.e., painter's drop cloth), periodically wipe it clean and replace it if torn.
3. Label each unattended radioactive material container with the radioactive symbol, isotope, activity, and, except for waste, the ICN [inventory control number]. Place containers too small for such labels in larger labeled containers.
4. Handle radioactive solutions in trays large enough to contain the material in the event of a spill.
5. Never eat, drink, smoke, handle contact lenses, apply cosmetics, or take/apply medicine in the lab; keep food, drinks, cosmetics, etc. out of the lab entirely. Do not pipette by mouth.
6. Never store [human] food and beverage in refrigerators/freezers used for storing radioisotopes.
7. Prevent skin contact with skin-absorbable solvents containing radioactive material.
8. Fume hoods and biological safety cabinets for use with non-airborne radioactive material must be approved (through the protocol) and must be labeled "Caution Radioactive Material".
9. All volatile, gaseous, or aerosolized radioactive material must be used only in a properly operating charcoal and/or HEPA filtered fume hood or Biological Safety Cabinet bearing a Caution Airborne Radioactivity hood label, unless otherwise specified in writing by the Radiation Safety Officer. In particular, radioactive iodination must be performed only in these specially designed fume hoods. The Radiation Safety Officer (through a protocol) must approve all such use.
10. Take special precautions when working with radioactive compounds that tend to become volatile [e.g. ^{35}S labeled amino acids, ^{125}I - iodine tends to volatilize in acidic solutions]. These precautions may include: using the materials only within an approved fume hood, protecting the house vacuum system with primary and secondary vapor trapping devices, and covering active cell cultures with carbon-impregnating paper.
11. Use sealed containers and appropriate secondary containment to carry radioactive material between rooms Notify Radiation Safety staff before taking any radioactive material off site.

^{14}C	Nuclide Safety Data Sheet Carbon-14	^{14}C

I. PHYSICAL DATA

Radiation:	Beta (100% abundance)	
Energy:	Max.: 156 keV; Average: 49 keV	
Half-Life [$T_{½}$] :	Physical $T_{½}$:	5730 years [link to web decay calculator][1]
	Biological $T_{½}$:	12 days
	Effective $T_{½}$:	Bound - 12 days; unbound - 40 days
Specific Activity:	4.46 Ci/g [0.165 TBq/g] max.	
Beta Range:	Air:	24 cm [10 inches]
	Water/Tissue:	0.28 mm [0.012 inches]
	[~1% of ^{14}C betas transmitted through dead skin layer, i.e. 0.007 cm depth]	
	Plastic:	0.25 mm [0.010 inches]

II. RADIOLOGICAL DATA

Radiotoxicity[2]:	6.36E-12 Sv/Bq [0.023 mrem/uCi] of $^{14}CO_2$ inhaled; 5.64E-10 Sv/Bq [2.09 mrem/uCi] organic compounds inhaled/ingested
Critical Organ:	Fat tissue [most labeled compounds]; bone [some labeled carbonates]
Exposure Routes:	Ingestion, inhalation, puncture, wound, skin contamination absorption
Radiological Hazard:	External Exposure - None from weak ^{14}C beta Internal Exposure & Contamination - Primary concern

III. SHIELDING

None required - mCi quantities not an external radiation hazard

IV. DOSIMETRY MONITORING

Urine bioassay is the most readily available method to assess intake [for ^{14}C, no intake = no dose]
Provide a urine sample to Radiation Safety whenever your monthly ^{14}C use exceeds 5 mCi, or after any accident/incident in which an intake is suspected

V. DETECTION & MEASUREMENT

Portable Survey Meters:	Geiger-Mueller [e.g. Bicron PGM, ~10% efficiency]; Beta Scintillator [e.g. Ludlum 44-21, ~5% efficiency]

Wipe Test: Liquid Scintillation Counting is the best readily available method for counting ^{14}C wipe tests

VI. SPECIAL PRECAUTIONS

- Avoid skin contamination [absorption], ingestion, inhalation, & injection [all routes of intake]
- Many ^{14}C compounds readily penetrate gloves and skin; handle such compounds remotely and wear double gloves, changing the outer pair at least every 20 minutes.

[1] URL for web-based decay calculator: http://ehs.ucsc.edu/rs/decay.html
[2] Federal Guidance Report No. 11 [Oak Ridge, TN; Oak Ridge National Laboratory, 1988], p. 122, 156

VII. GENERAL PRECAUTIONS

1. Maintain your occupational exposure to radiation As Low As Reasonably Achievable [ALARA].
2. Ensure all persons handling radioactive material are trained, registered, & listed on an approved protocol.
3. Review the nuclide characteristics on (reverse side) prior to working with that nuclide. Review the protocol(s) authorizing the procedure to be performed and follow any additional precautions in the protocol. Contact the responsible Principal Investigator to view the protocol information.
4. Plan experiments to minimize external exposure by reducing exposure time, using shielding and increasing your distance from the radiation source. Reduce internal and external radiation dose by monitoring the worker and the work area after each use of radioactive material, then promptly cleaning up any contamination discovered. Use the smallest amount of radioisotope possible so as to minimize radiation dose and radioactive waste.
5. Keep an accurate inventory of radioactive material, including records of all receipts, transfers & disposal. Perform and record regular lab surveys.
6. Provide for safe disposal of radioactive waste by following institutional Waste Handling & Disposal Procedures. Avoid generating mixed waste (combinations of radioactive, biological, and chemical waste). Note lab that staff may not pour measurable quantities of radioactive material down the drain.
7. If there is a question regarding any aspect of the radiation safety program or radioactive material use, contact Radiation Safety.

VIII. LAB PRACTICES

1. Disposable gloves, lab coats, and safety glasses are the minimum PPE [Personal Protective Equipment] required when handling radioactive material. Remove & discard potentially contaminated PPE prior to leaving the area where radioactive material is used.
2. Clearly outline radioactive material use areas with tape bearing the legend "radioactive". Cover lab bench tops where radioactive material will be handled with plastic-backed absorbent paper; change this covering periodically and whenever it's contaminated. Alternatively cover benches with thick plastic sheeting (i.e., painter's drop cloth), periodically wipe it clean and replace it if torn.
3. Label each unattended radioactive material container with the radioactive symbol, isotope, activity, and, except for waste, the ICN [inventory control number]. Place containers too small for such labels in larger labeled containers.
4. Handle radioactive solutions in trays large enough to contain the material in the event of a spill.
5. Never eat, drink, smoke, handle contact lenses, apply cosmetics, or take/apply medicine in the lab; keep food, drinks, cosmetics, etc. out of the lab entirely. Do not pipette by mouth.
6. Never store [human] food and beverage in refrigerators/freezers used for storing radioisotopes.
7. Prevent skin contact with skin-absorbable solvents containing radioactive material.
8. Fume hoods and biological safety cabinets for use with non-airborne radioactive material must be approved (through the protocol) and must be labeled "Caution Radioactive Material".
9. All volatile, gaseous, or aerosolized radioactive material must be used only in a properly operating charcoal and/or HEPA filtered fume hood or Biological Safety Cabinet bearing a Caution Airborne Radioactivity hood label, unless otherwise specified in writing by the Radiation Safety Officer. In particular, radioactive iodination must be performed only in these specially designed fume hoods. The Radiation Safety Officer (through a protocol) must approve all such use.
10. Take special precautions when working with radioactive compounds that tend to become volatile [e.g. ^{35}S labeled amino acids, ^{125}I - iodine tends to volatilize in acidic solutions]. These precautions may include: using the materials only within an approved fume hood, protecting the house vacuum system with primary and secondary vapor trapping devices, and covering active cell cultures with carbon-impregnating paper.
11. Use sealed containers and appropriate secondary containment to carry radioactive material between rooms Notify Radiation Safety staff before taking any radioactive material off site.

^{32}P	Nuclide Safety Data Sheet Phosphorous-32 **www.nchps.org**	^{32}P

I. PHYSICAL DATA

Radiation:	Beta (100% abundance)	
Energy:	Maximum: 1,710 keV; Average: 695 keV	
Half-Life [$T_{½}$] :	Physical $T_{½}$:	14.29 days
	Biological $T_{½}$:	Bone ~ 1155 days; Whole Body ~ 257 days[1]
	Effective $T_{½}$:	14.29 days
Specific Activity:	286,500 Ci/g [10,600 TBq/g] max.	
Beta Range:	Air:	610 cm [240 inches; 20 feet]
	Water/Tissue:	0.76 cm [0.33 inches]
	Plastic:	0.61 mm [3/8 inches]

II. RADIOLOGICAL DATA

Radiotoxicity[2]: Inhaled: 2.6E-8 Sv/Bq [95 mrem/uCi] Lung; 4.2E-9 Sv/Bq [16 mrem/uCi] CEDE
Ingested: 8.1E-9 Sv/Bq [30 mrem/uCi] Marrow; 2.4E-9 Sv/Bq [8.8 mrem/uCi] CEDE
Critical Organ: Bone [soluble ^{32}P]; Lung [Inhalation]; GI Tract [Ingestion - insoluble compounds]
Exposure Routes: Ingestion, inhalation, puncture, wound, skin contamination absorption
Radiological Hazard: External Exposure [unshielded dose rate at 1 mCi ^{32}P vial mouth[3]: approx. 26 rem/hr], Internal Exposure & Contamination

III. SHIELDING

Shield ^{32}P with 3/8 inch Plexiglas and monitor for Bremstrahlung; If Bremstrahlung X-rays detected outside Plexiglas, apply 1/8 to 1/4 inch lead [Pb] shielding outside Plexiglas
The accessible dose rate should be background but must be < 2 mR/hr

IV. DOSIMETRY MONITORING

Always wear radiation dosimetry monitoring badges [body & ring] whenever handling ^{32}P

V. DETECTION & MEASUREMENT

Portable Survey Meters: Geiger-Mueller [e.g. Bicron PGM];
Beta Scintillator [e.g. Ludlum 44-21]
Wipe Test: Liquid Scintillation Counting is an acceptable method for counting ^{32}P wipe tests

VI. SPECIAL PRECAUTIONS

- Avoid skin contamination [absorption], ingestion, inhalation, & injection [all routes of intake].
- Store ^{32}P (including waste) behind Plexiglas shielding [3/8 inch thick]; survey (with GM meter) to check adequacy of shielding (accessible dose rate < 2 mR/hr; should be background); apply lead [Pb] shielding outside Plexiglas if needed.
- Use 3/8 inch Plexiglas shielding to minimize exposure while handling ^{32}P.
- Use tools [e.g. Beta Blocks] to handle ^{32}P sources and contaminated objects; avoid direct hand contact.
- Always have a portable survey meter present and turned on when handling ^{32}P.
- ^{32}P is not volatile, even when heated, and can be ignored as an airborne contaminant[4] unless aerosolized.
- White vinegar can be an effective decontamination solvent for this nuclide in most forms.

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[1] NCRP Report No. 65, p.88
[2] Federal Guidance Report No. 11 [Oak Ridge, TN; Oak Ridge National Laboratory, 1988], p. 122, 156
[3] Dupont/NEN, Phosphorous-32 Handling Precautions [Boston, MA; NEN Products, 1985]
[4] Bevelacqua, J. Contemporary Health Physics [New York; John Wiley & Sons, 1995], p. 282

VII. GENERAL PRECAUTIONS

1. Maintain your occupational exposure to radiation As Low As Reasonably Achievable [ALARA].
2. Ensure all persons handling radioactive material are trained, registered, & listed on an approved protocol.
3. Review the nuclide characteristics on (reverse side) prior to working with that nuclide. Review the protocol(s) authorizing the procedure to be performed and follow any additional precautions in the protocol. Contact the responsible Principal Investigator to view the protocol information.
4. Plan experiments to minimize external exposure by reducing exposure time, using shielding and increasing your distance from the radiation source. Reduce internal and external radiation dose by monitoring the worker and the work area after each use of radioactive material, then promptly cleaning up any contamination discovered. Use the smallest amount of radioisotope possible so as to minimize radiation dose and radioactive waste.
5. Keep an accurate inventory of radioactive material, including records of all receipts, transfers & disposal. Perform and record regular lab surveys.
6. Provide for safe disposal of radioactive waste by following institutional Waste Handling & Disposal Procedures. Avoid generating mixed waste (combinations of radioactive, biological, and chemical waste). Note lab staff are not permitted to pour measurable quantities of radioactive material down the drain.
7. If there is a question regarding any aspect of the radiation safety program or radioactive material use, contact Radiation Safety.

VIII. LAB PRACTICES

1. Disposable gloves, lab coats, and safety glasses are the minimum PPE [Personal Protective Equipment] required when handling radioactive material. Remove & discard potentially contaminated PPE prior to leaving the area where radioactive material is used.
2. Clearly outline radioactive material use areas with tape bearing the legend "radioactive". Cover lab bench tops where radioactive material will be handled with plastic-backed absorbent paper; change this covering periodically and whenever it's contaminated. Alternatively cover benches with thick plastic sheeting (i.e., painter's drop cloth), periodically wipe it clean and replace it if torn.
3. Label each unattended radioactive material container with the radioactive symbol, isotope, activity, and, except for waste, the ICN [inventory control number]. Place containers too small for such labels in larger labeled containers.
4. Handle radioactive solutions in trays large enough to contain the material in the event of a spill.
5. Never eat, drink, smoke, handle contact lenses, apply cosmetics, or take/apply medicine in the lab; keep food, drinks, cosmetics, etc. out of the lab entirely. Do not pipette by mouth.
6. Never store [human] food and beverage in refrigerators/freezers used for storing radioisotopes.
7. Prevent skin contact with skin-absorbable solvents containing radioactive material.
8. Fume hoods and biological safety cabinets for use with non-airborne radioactive material must be approved (through the protocol) and must be labeled "Caution Radioactive Material".
9. All volatile, gaseous, or aerosolized radioactive material must be used only in a properly operating charcoal and/or HEPA filtered fume hood or Biological Safety Cabinet bearing a Caution Airborne Radioactivity hood label, unless otherwise specified in writing by the Radiation Safety Officer. In particular, radioactive iodination must be performed only in these specially designed fume hoods. The Radiation Safety Officer (through a protocol) must approve all such use.
10. Take special precautions when working with radioactive compounds that tend to become volatile [e.g. ^{35}S labeled amino acids, ^{125}I - iodine tends to volatilize in acidic solutions]. These precautions may include: using the materials only within an approved fume hood, protecting the house vacuum system with primary and secondary vapor trapping devices, and covering active cell cultures with carbon-impregnating paper.
11. Use sealed containers and appropriate secondary containment to carry radioactive material between rooms Notify Radiation Safety staff before taking any radioactive material off site.

^{35}S	Nuclide Safety Data Sheet Sulfur-35 **www.nchps.org**	^{35}S

I. PHYSICAL DATA

Radiation:	Beta (100% abundance)	
Energy:	Maximum: 167.47 keV; Average: 48.8 keV	
Half-Life [T½] :	Physical T½:	87.44 days
	Biological T½:	623 days [unbound ^{35}S]; 90 days [bound ^{35}S]
	Effective T½:	44 - 76 days [unbound ^{35}S]
Specific Activity:	42,707 Ci/g [1,580 TBq/g] max.	
Beta Range:	Air:	26 cm [10.2 inches]
	Water/Tissue:	0.32 mm [0.015 inches]
	Plastic:	0.25 mm [0.010 inches]

II. RADIOLOGICAL DATA

Radiotoxicity[1]:	2.48 mrem/uCi [CEDE] of ^{35}S inhaled 0.733 mrem/uCi of ^{35}S ingested
Critical Organ:	Testis
Exposure Routes:	Ingestion, inhalation, puncture, wound, skin contamination absorption
Radiological Hazard:	External Exposure - None from weak ^{35}S beta Internal Exposure & Contamination - Primary concern

III. SHIELDING

None required - mCi quantities not an external radiation hazard

IV. DOSIMETRY MONITORING

Urine bioassay is the most readily available method to assess intake [for ^{35}S, no intake = no dose]
Provide a urine sample to Radiation Safety whenever your monthly ^{35}S use exceeds 5 mCi, or after any accident/incident in which an intake is suspected

V. DETECTION & MEASUREMENT

Portable Survey Meters: Geiger-Mueller [e.g. Bicron PGM, ~10% efficiency]
Beta Scintillator [e.g. Ludlum 44-21, ~5% efficiency]

Wipe Test: Liquid Scintillation Counting is the best readily available method for counting ^{35}S wipe tests

VI. SPECIAL PRECAUTIONS

- Avoid skin contamination [absorption], ingestion, inhalation, & injection [all routes of intake]
- Many ^{35}S compounds and metabolites are slightly volatile and may create contamination problems if not sealed or otherwise controlled. This occurs particularly when ^{35}S amino acids are thawed, and when they are added to cell culture media and incubated. Therefore vent thawing ^{35}S vials in a hood by inserting the needle of a charcoal packed syringe through the septum seal, and vent incubated ^{35}S-labelled tissue culture through charcoal-impregnated filter paper.

[1] Federal Guidance Report No. 11 [Oak Ridge, TN; Oak Ridge National Laboratory, 1988], p. 122, 156

VII. GENERAL PRECAUTIONS

1. Maintain your occupational exposure to radiation As Low As Reasonably Achievable [ALARA].
2. Ensure all persons handling radioactive material are trained, registered, & listed on an approved protocol.
3. Review the nuclide characteristics on (reverse side) prior to working with that nuclide. Review the protocol(s) authorizing the procedure to be performed and follow any additional precautions in the protocol. Contact the responsible Principal Investigator to view the protocol information.
4. Plan experiments to minimize external exposure by reducing exposure time, using shielding and increasing your distance from the radiation source. Reduce internal and external radiation dose by monitoring the worker and the work area after each use of radioactive material, then promptly cleaning up any contamination discovered. Use the smallest amount of radioisotope possible so as to minimize radiation dose and radioactive waste.
5. Keep an accurate inventory of radioactive material, including records of all receipts, transfers & disposal. Perform and record regular lab surveys.
6. Provide for safe disposal of radioactive waste by following Waste Handling & Disposal Procedures. Avoid generating mixed waste (combinations of radioactive, biological, and chemical waste). Note that lab staff may not pour measurable quantities of radioactive material down the drain.
7. If there is a question regarding any aspect of the radiation safety program or radioactive material use, contact Radiation Safety.

VIII. LAB PRACTICES

1. Disposable gloves, lab coats, and safety glasses are the minimum PPE [Personal Protective Equipment] required when handling radioactive material. Remove & discard potentially contaminated PPE prior to leaving the area where radioactive material is used.
2. Clearly outline radioactive material use areas with tape bearing the legend "radioactive". Cover lab bench tops where radioactive material will be handled with plastic-backed absorbent paper; change this covering periodically and whenever it's contaminated. Alternatively cover benches with thick plastic sheeting (i.e., painter's drop cloth), periodically wipe it clean and replace it if torn.
3. Label each unattended radioactive material container with the radioactive symbol, isotope, activity, and, except for waste, the ICN [inventory control number]. Place containers too small for such labels in larger labeled containers.
4. Handle radioactive solutions in trays large enough to contain the material in the event of a spill.
5. Never eat, drink, smoke, handle contact lenses, apply cosmetics, or take/apply medicine in the lab; keep food, drinks, cosmetics, etc. out of the lab entirely. Do not pipette by mouth.
6. Never store [human] food and beverage in refrigerators/freezers used for storing radioisotopes.
7. Prevent skin contact with skin-absorbable solvents containing radioactive material.
8. Fume hoods and biological safety cabinets for use with non-airborne radioactive material must be approved (through the protocol) and must be labeled "Caution Radioactive Material".
9. All volatile, gaseous, or aerosolized radioactive material must be used only in a properly operating charcoal and/or HEPA filtered fume hood or Biological Safety Cabinet bearing a Caution Airborne Radioactivity hood label, unless otherwise specified in writing by the Radiation Safety Officer. In particular, radioactive iodination must be performed only in these specially designed fume hoods. The Radiation Safety Officer (through a protocol) must approve all such use.
10. Take special precautions when working with radioactive compounds that tend to become volatile [e.g. ^{35}S labeled amino acids, ^{125}I - iodine tends to volatilize in acidic solutions]. These precautions may include: using the materials only within an approved fume hood, protecting the house vacuum system with primary and secondary vapor trapping devices, and covering active cell cultures with carbon-impregnating paper.
11. Use sealed containers and appropriate secondary containment to carry radioactive material between rooms Notify Radiation Safety staff before taking any radioactive material off site.

^{65}Zn	Nuclide Safety Data Sheet Zinc-65 www.nchps.org	^{65}Zn

I. PHYSICAL DATA

Radiation:	Gamma – 1,116 keV (51% abundance)	
	Annihilation photons - 511 keV (3% abundance)	
	Beta – 330 keV (2% abundance)	
Gamma Constant:	0.33 mR/hr per mCi @ 1.0 meter [8.92E-5 mSv/hr per MBq @ 1.0 meter][a]	
Half-Life [$T_{½}$]:	Physical $T_{½}$:	244.4 days[a]
	Biological$T_{½}$:	2.35 days (inhalation); 4 days (ingestion) excreted via feces (75%) & urine (25%)[b]
	Effective $T_{½}$:	whole body: ~2.3 days (inhalation); ~4 days (ingestion)
Specific Activity[c]:	8,243 Ci/g [3.05E14 Bq/g] max.	

II. RADIOLOGICAL DATA

Radiotoxicity[d]:	14.4 mrem/uCi [3.9 E-9 Sv/Bq] of ^{65}Zn ingested [CEDE] 20.4 mrem/uCi [5.51E-9 Sv/Bq] of ^{65}Zn inhaled [CEDE]
Critical Organ:	Bone Marrow
Intake Routes:	Ingestion, inhalation, puncture, wound, skin contamination (absorption);
Radiological Hazard:	External & Internal Exposure; Contamination

III. SHIELDING

	Half Value Layer [HVL]	Tenth Value Layer [TVL]
Lead [Pb][c]	14 mm (9/16 inches)	42 mm (1 & 5/8 inches)

The accessible dose rate should be background but must be < 2 mR/hr

IV. DOSIMETRY MONITORING

Always wear radiation dosimetry monitoring badges [body & ring] whenever handling ^{65}Zn

V. DETECTION & MEASUREMENT

Portable Survey Meters	Geiger-Mueller [e.g. Bicron PGM] to assess shielding effectiveness
	Low Energy Gamma Detector [e.g. Ludlum 44-21] for contamination surveys
Wipe Test:	Liquid Scintillation Counter

VI. SPECIAL PRECAUTIONS

- Store ^{65}Zn (including waste) behind lead shielding [½+ inch thick]; lead bricks may be necessary. Survey (with GM meter) to check adequacy of shielding (accessible dose rate < 2 mR/hr; should be background)
- Avoid skin contamination [absorption], ingestion, inhalation, & injection [all routes of intake]
- Use shielding to minimize exposure while handling ^{65}Zn
- Use tools to handle ^{65}Zn sources and contaminated objects; avoid direct hand contact. Near ^{65}Zn sources, the beta dose rate can be much higher than the gamma dose rate.

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[a] Health Physics & Radiological Health Handbook, 3rd Ed. [Baltimore, MD; Williams & Wilkins, 1998], p. 6-9

[b] Interpolation from intake retention factors, from NUREG/CR-4884 Interpretation of Bioassay Measurements (US Nuclear Regulatory Commission, 1987), p. B-381, B-531

[c] Delacroix et al, Radiation Protection Dosimetry - Radionuclide and Radiation Protection Data Handbook (Kent, England: Nuclear Technology Publishing, 2002), p. 62

[d] Federal Guidance Report No. 11. EPA 520/1-88-020, 1988, p. 158 & .

VII. GENERAL PRECAUTIONS

1. Maintain your occupational exposure to radiation As Low As Reasonably Achievable [ALARA].
2. Ensure all persons handling radioactive material are trained, registered, & listed on an approved protocol.
3. Review the nuclide characteristics on (reverse side) prior to working with that nuclide. Review the protocol(s) authorizing the procedure to be performed and follow any additional precautions in the protocol. Contact the responsible Principal Investigator to view the protocol information.
4. Plan experiments to minimize external exposure by reducing exposure time, using shielding and increasing your distance from the radiation source. Reduce internal and external radiation dose by monitoring the worker and the work area after each use of radioactive material, then promptly cleaning up any contamination discovered. Use the smallest amount of radioisotope possible so as to minimize radiation dose and radioactive waste.
5. Keep an accurate inventory of radioactive material, including records of all receipts, transfers & disposal. Perform and record regular lab surveys.
6. Provide for safe disposal of radioactive waste by following institutional Waste Handling & Disposal Procedures. Avoid generating mixed waste (combinations of radioactive, biological, and chemical waste). Note that lab staff may not pour measurable quantities of radioactive material down the drain.
7. If there is a question regarding any aspect of the radiation safety program or radioactive material use, contact Radiation Safety.

VIII. LAB PRACTICES

1. Disposable gloves, lab coats, and safety glasses are the minimum PPE [Personal Protective Equipment] required when handling radioactive material. Remove & discard potentially contaminated PPE prior to leaving the area where radioactive material is used.
2. Clearly outline radioactive material use areas with tape bearing the legend "radioactive". Cover lab bench tops where radioactive material will be handled with plastic-backed absorbent paper; change this covering periodically and whenever it's contaminated. Alternatively cover benches with thick plastic sheeting (i.e., painter's drop cloth), periodically wipe it clean and replace it if torn.
3. Label each unattended radioactive material container with the radioactive symbol, isotope, activity, and, except for waste, the ICN [inventory control number]. Place containers too small for such labels in larger labeled containers.
4. Handle radioactive solutions in trays large enough to contain the material in the event of a spill.
5. Never eat, drink, smoke, handle contact lenses, apply cosmetics, or take/apply medicine in the lab; keep food, drinks, cosmetics, etc. out of the lab entirely. Do not pipette by mouth.
6. Never store [human] food and beverage in refrigerators/freezers used for storing radioisotopes.
7. Prevent skin contact with skin-absorbable solvents containing radioactive material.
8. Fume hoods and biological safety cabinets for use with non-airborne radioactive material must be approved (through the protocol) and must be labeled "Caution Radioactive Material".
9. All volatile, gaseous, or aerosolized radioactive material must be used only in a properly operating charcoal and/or HEPA filtered fume hood or Biological Safety Cabinet bearing a Caution Airborne Radioactivity hood label, unless otherwise specified in writing by the Radiation Safety Officer. In particular, radioactive iodination must be performed only in these specially designed fume hoods. The Radiation Safety Officer (through a protocol) must approve all such use.
10. Take special precautions when working with radioactive compounds that tend to become volatile [e.g. ^{35}S labeled amino acids, ^{125}I - iodine tends to volatilize in acidic solutions]. These precautions may include: using the materials only within an approved fume hood, protecting the house vacuum system with primary and secondary vapor trapping devices, and covering active cell cultures with carbon-impregnating paper.
11. Use sealed containers and appropriate secondary containment to carry radioactive material between rooms Notify Radiation Safety staff before taking any radioactive material off site.

^{90}Sr	Nuclide Safety Data Sheet Strontium-90 **www.nchps.org**	^{90}Sr

I. PHYSICAL DATA

Primary Radiation[1]: Beta – 546 keV (100%); ^{90}Y Betas – 2,484 keV (~100%), 523 keV (<1%)

Skin Dose Rate[1]: 7.3E2 mrem/hr at 30 cm from 1 uCi [0.20 mSv/hr at 30 cm from 1 MBq]

Physical Half-Life[1] [$T_{½}$] 28.2 years

Specific Activity[1]: 1.41E2 Ci/g [5.21E12 Bq/g]

II. RADIOLOGICAL DATA

Radiotoxicity[2]:	Ingested:	1.6E3 mrem/uCi [4.19E-7 Sv/Bq] Bone
		1.4E2 mrem/uCi [3.85E-8 mSv/Bq] CEDE
	Inhaled:	1.1E4 mrem/uCi [2.86E-6 mSv/Bq] Lung
		1.3E3 mrem/uCi [3.51E-7 mSv/Bq] CEDE
Critical Organ:	Bone [ingestion][2]; Lungs [inhalation][1]	
Intake Routes:	Ingestion, inhalation, puncture, wound, skin contamination (absorption);	
Radiological Hazard:	Internal and External Exposure, Contamination	

III. SHIELDING

Plexiglas[1] 9.2 mm

→ The accessible dose rate should be background but must be < 2 mR/hr

IV. DOSIMETRY MONITORING

- Always wear radiation dosimetry monitoring badges [body & ring] whenever handling ^{90}Sr

V. DETECTION & MEASUREMENT

Portable Survey Meters: Geiger-Mueller [e.g. Bicron PGM] to assess shielding effectiveness & locate contamination

Wipe Test: Gamma counter, well counter or liquid scintillation counter

VI. SPECIAL PRECAUTIONS

- Store ^{90}Sr behind 12 mm [1/2 inch] or thicker plastic (e.g. Plexiglas) shielding as necessary to keep accessible dose rate low [< 2 mR/hr]
- Use tools (e.g. tongs, forceps; plastic blocks) to indirectly handle unshielded sources and potentially contaminated vessels; avoid direct hand contact
- Ensure that an appropriate, operational survey meter (e.g. Bicron PGM) is present in the work area and turned on whenever ^{90}Sr is handled, so that any external exposure issues will be immediately apparent and hence quickly addressed
- Shield waste containers as needed to maintain accessible dose rate ALARA and < 2 mR/hr

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[1] Delacroix et al, Radiation Protection Dosimetry - Radionuclide and Radiation Protection Data Handbook (Kent, England: Nuclear Technology Publishing, 2002), p. 80

[2] Federal Guidance Report No. 11 [Oak Ridge, TN; Oak Ridge National Laboratory, 1988], p. 128, 160

VII. GENERAL PRECAUTIONS

1. Maintain your occupational exposure to radiation As Low As Reasonably Achievable [ALARA].
2. Ensure all persons handling radioactive material are trained, registered, & listed on an approved protocol.
3. Review the nuclide characteristics on (reverse side) prior to working with that nuclide. Review the protocol(s) authorizing the procedure to be performed and follow any additional precautions in the protocol. Contact the responsible Principal Investigator to view the protocol information.
4. Plan experiments to minimize external exposure by reducing exposure time, using shielding and increasing your distance from the radiation source. Reduce internal and external radiation dose by monitoring the worker and the work area after each use of radioactive material, then promptly cleaning up any contamination discovered. Use the smallest amount of radioisotope possible so as to minimize radiation dose and radioactive waste.
5. Keep an accurate inventory of radioactive material, including records of all receipts, transfers & disposal. Perform and record regular lab surveys.
6. Provide for safe disposal of radioactive waste by following institutional Waste Handling & Disposal Procedures. Avoid generating mixed waste (combinations of radioactive, biological, and chemical waste). Note that lab staff may not pour measurable quantities of radioactive material down the drain.
7. If there is a question regarding any aspect of the radiation safety program or radioactive material use, contact Radiation Safety.

VIII. LAB PRACTICES

1. Disposable gloves, lab coats, and safety glasses are the minimum PPE [Personal Protective Equipment] required when handling radioactive material. Remove & discard potentially contaminated PPE prior to leaving the area where radioactive material is used.
2. Clearly outline radioactive material use areas with tape bearing the legend "radioactive". Cover lab bench tops where radioactive material will be handled with plastic-backed absorbent paper; change this covering periodically and whenever it's contaminated. Alternatively cover benches with thick plastic sheeting (i.e., painter's drop cloth), periodically wipe it clean and replace it if torn.
3. Label each unattended radioactive material container with the radioactive symbol, isotope, activity, and, except for waste, the ICN [inventory control number]. Place containers too small for such labels in larger labeled containers.
4. Handle radioactive solutions in trays large enough to contain the material in the event of a spill.
5. Never eat, drink, smoke, handle contact lenses, apply cosmetics, or take/apply medicine in the lab; keep food, drinks, cosmetics, etc. out of the lab entirely. Do not pipette by mouth.
6. Never store [human] food and beverage in refrigerators/freezers used for storing radioisotopes.
7. Prevent skin contact with skin-absorbable solvents containing radioactive material.
8. Fume hoods and biological safety cabinets for use with non-airborne radioactive material must be approved (through the protocol) and must be labeled "Caution Radioactive Material".
9. All volatile, gaseous, or aerosolized radioactive material must be used only in a properly operating charcoal and/or HEPA filtered fume hood or Biological Safety Cabinet bearing a Caution Airborne Radioactivity hood label, unless otherwise specified in writing by the Radiation Safety Officer. In particular, radioactive iodination must be performed only in these specially designed fume hoods. The Radiation Safety Officer (through a protocol) must approve all such use.
10. Take special precautions when working with radioactive compounds that tend to become volatile [e.g. ^{35}S labeled amino acids, ^{125}I - iodine tends to volatilize in acidic solutions], such as: use the materials only within an approved fume hood; protect the house vacuum system with primary & secondary vapor trapping devices; and cover active cell cultures with carbon-impregnated paper.
11. Use sealed containers and appropriate secondary containment to carry radioactive material between rooms. Notify Radiation Safety staff before taking any radioactive material off site.

RADIONUCLIDE SAFETY DATA SHEET

NUCLIDE: Cd-109 **FORMS: SOLUBLE**

PHYSICAL CHARACTERISTICS:

HALF-LIFE: 464 days TYPE DECAY: e^- capture

maximum energies e^- (MeV): 0.087 (10 %), .084 (44%), .063 (42%)

Energies of photons (intensity %/d): 0.088 (4%), 0.025 (18 %), 0.022 (84%)

Hazard category: C- level (low hazard) : .010 to 1.0 mCi
B - level (Moderate hazard) : > 1.0 mCi to 100 mCi
A - level (High hazard) : > greater than 100 mCi

EXTERNAL RADIATION HAZARDS AND SHIELDING:

The gamma exposure constant is 1.86 R-cm^2/mCi-hr. The amount of lead necessary to reduce the exposure rate by a factor of ten is 0.024 cm. The electrons emitted are at a low energy and do not constitute an external hazard.

HAZARDS IF INTERNALLY DEPOSITED:

Contamination of facilities and bodies is a more significant hazard than the external dose -- use of gloves and frequent monitoring while working are important. The annual limit of intake (oral) for this nuclide, based upon 10% of the dose limit to the kidneys is 27 uCi.

DOSIMETRY AND BIOASSAY REQUIREMENTS:

Film badges and finger dosimeters are not very useful when handling mCi amounts of Cd^{109}.

Urine assays may be required after spills or contamination incidents.

SPECIAL PROBLEMS AND PRECAUTIONS:

1. Always wear protective gloves to keep contamination from skin. Change gloves often.
2. Survey work areas at conclusion of work. Smear surveys are required for uncontrolled areas.
3. Segregate wastes to those with half-lives of greater than 90 days (but not with H3 and/or C14).
4. Limit of soluble waste to sewer to 10 microcuries/ day per lab.

6/90

^{125}I	Nuclide Safety Data Sheet Iodine-125 **www.nchps.org**	^{125}I

I. PHYSICAL DATA

Radiation:	Gamma - 35.5 keV (7% abundance)
	X-ray - 27 keV (113% abundance)
Gamma Constant:	0.27 mR/hr per mCi @ 1.0 meter [7.432E-5 mSv/hr per MBq @ 1.0 meter][1]
Half-Life [$T_{½}$] :	Physical $T_{½}$: 60.14 days
	Biological $T_{½}$: 120-138 days (unbound iodine)
	Effective $T_{½}$: 42 days (unbound iodine)
Specific Activity:	1.73E4 Ci/g [642 TBq/g] max.

II. RADIOLOGICAL DATA

Radiotoxicity[2]:	3.44E-7 Sv/Bq (1273 mrem/μCi) of ^{125}I ingested [Thyroid]
	2.16 E-7 Sv/Bq (799 mrem/μCi) of ^{125}I inhaled [Thyroid]
Critical Organ:	Thyroid Gland
Intake Routes:	Ingestion, inhalation, puncture, wound, skin contamination (absorption);
Radiological Hazard:	External & Internal Exposure; Contamination

III. SHIELDING

	Half Value Layer [HVL]	Tenth Value Layer [TVL]
Lead [Pb]	0.02 mm (0.0008 inches)	0.07 mm (0.003 inches)

→ The accessible dose rate should be background but must be < 2 mR/hr

IV. DOSIMETRY MONITORING

- Always wear radiation dosimetry monitoring badges [body & ring] whenever handling ^{125}I
- Conduct a baseline thyroid scan prior to first use of radioactive iodine
- Conduct thyroid scan no earlier than 6 hours but within 72 hours of handling 1 mCi or more of ^{125}I or after any suspected intake

V. DETECTION & MEASUREMENT

Portable Survey Meters:

Geiger-Mueller [e.g. Bicron PGM,] to assess shielding effectiveness

Low Energy Gamma Detector [e.g. Ludlum 44-21, ~19% eff. for ^{125}I] for contamination surveys

Wipe Test: Liquid Scintillation Counter

VI. SPECIAL PRECAUTIONS

- Avoid skin contamination [absorption], ingestion, inhalation, & injection [all routes of intake]
- Use shielding [lead or leaded Plexiglas] to minimize exposure while handling mCi quantities of ^{125}I
- Avoid making low pH [acidic] solutions containing ^{125}I to avoid volatilization
- For Iodinations:
  - Use a cannula adapter needle to vent stock vials of ^{125}I used; this prevents puff releases
  - Cover test tubes used to count or separate fractions from iodinations with parafilm or other tight caps to prevent release while counting or moving outside the fume hood.

[1] Health Physics & Radiological Health Handbook, 3rd Ed. [Baltimore, MD; Williams & Wilkins, 1998], p. 6-11

[2] Federal Guidance Report No. 11 [Oak Ridge, TN; Oak Ridge National Laboratory, 1988], p. 136, 166

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5. Keep an accurate inventory of radioactive material, including records of all receipts, transfers & disposal. Perform and record regular lab surveys.
6. Provide for safe disposal of radioactive waste by following DU/DUMC Waste Handling & Disposal Procedures - http://www.safety.duke.edu/EnviroPrograms/Radiopro.htm. Avoid generating mixed waste (combinations of radioactive, biological, and chemical waste). Note lab staff are not permitted to pour measurable quantities of radioactive material down the drain.
7. If there is a question regarding any aspect of the radiation safety program or radioactive material use, contact Radiation Safety at 684-2194.

VIII. LAB PRACTICES

1. Disposable gloves, lab coats, and safety glasses are the minimum PPE [Personal Protective Equipment] required when handling radioactive material. Remove & discard potentially contaminated PPE prior to leaving the area where radioactive material is used.
2. Clearly outline radioactive material use areas with tape bearing the legend "radioactive". Cover lab bench tops where radioactive material will be handled with plastic-backed absorbent paper; change this covering periodically and whenever it's contaminated. Alternatively cover benches with thick plastic sheeting (i.e., painter's drop cloth), periodically wipe it clean and replace it if torn.
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