



Radiation Safety Manual

I. Program Description and Regulations

A. Program Description

California State University, Fullerton (CSUF) operates under a Broad Scope radioactive materials license issued by the California Department of Public Health, Radiologic Health Branch (RHB). All use of radioactive materials and radiation-producing machines is governed by the provisions of Title 17 (California Code of Regulations Title 17), 10 CFR 20 (Code of Federal Regulations, Title 10, Chapter 1 part 20) and any additional provisions given in this manual.

The campus program is implemented by the Radiation Safety Officer (RSO) and the Radiation Safety Committee (RSC). The RSO and the RSC Chair(s) are named specifically on the university's license and approved by the RHB.

CSUF commits to restricting the possession of radioactive materials at all times to less than that requiring financial surety for decommissioning and that requiring a decommissioning funding plan in accordance with 10 CFR 30.35.

CSUF will review the Radiation Safety Program on an annual basis and that the review documentation will be maintained for inspection.

B. Radiation Safety Committee (RSC)

The RSC is required for a Type B License. It is composed of at least five members consisting of the RSO and representatives from the administration and operating groups. Except for administration, all members must be qualified as authorized users.

The Committee shall hold meetings at least on a quarterly basis. Additional meetings can be called by the Chair or the RSO at other times to consider special problems or applications which cannot wait for consideration at the next regular meeting. A quorum for the purpose of conducting committee business should consist of at least a simple majority of the membership, and must include the RSO. Additional persons may join the Committee, when necessary, in a non-voting status.

C. RSC Responsibilities

The RSC:

1. Is responsible for the review and authorization of all radiation use on campus and for prescribing special conditions and reviewing minor program changes.

2. Is responsible for ensuring that radioactive materials and radiation-producing devices are used safely and in accordance with State and Federal regulations.
3. Interacts with the RSO in establishing the policies governing the use of radiation and acts as the ultimate campus reviewing agent concerning all cases involving the use of radioactive material or radiation-producing machines and equipment, and any significant changes to any facility or equipment use policy.
4. Works with the RSO to determine that all individuals authorized to use radiation-producing devices and radioactive materials have sufficient training to enable them to perform their duties safely.
5. Can disapprove all proposals that do not meet the university policies or the federal, state, or county regulations.
6. Can terminate the use of radioactive materials by individuals who do not comply with all federal, state, or county regulations.
7. Can apply other restrictions on the use of radioactive materials and radiation-producing devices to comply with all regulations and policies.
8. Keeps and maintains a record of all of its transactions and reports. These records shall be kept in the RSO files.

D. RSC Member Responsibilities

Each member of the RSC is expected to make every effort to attend all meetings. Members must designate alternates who can stand-in when a member cannot make a meeting. The alternate may vote in Committee decisions.

If a committee member cannot attend meetings due to a long-term off-site project, illness, sabbatical leave, or other duties which remove him or her from normal campus activities for an extended period of time (more than 2 calendar quarters), another person of similar status shall be temporarily placed on the committee until the regular committee member returns. The temporary member must meet the same criteria as permanent members and be approved by the RSC.

E. Radiation Safety Officer (RSO)

The RSO of the Office of Environmental Health & Safety is responsible for managing and implementing the CSUF Radiation Safety Program.

The RSO has the responsibility of interacting with the RSC in the formulation of radiation policies and procedures, and acts as the administrative arm of the RSC in the implementation of those policies and applicable regulations. In an emergency, the RSO has the authority to initiate necessary actions without prior RSC review. RSO actions are subsequently open for review by the RSC. The main responsibility of the

RSO is to provide leadership to the campus in the area of health physics, with guidance from the RSC, and ensure that the terms of the University radioactive materials license are strictly observed. The RSO and designee(s) will conduct an annual review of the Radiation Safety Program and report findings to the RSC. The specific duties necessary to carry out these responsibilities include:

1. Evaluate prospective users of radionuclides and present findings to the RSC.
2. Conduct radiation surveys, leak tests, and regular inspections of radiation areas.
3. Responsible for all records and disposal of radioactive materials and radiation equipment received at CSUF.
4. Maintain an inventory of all radioactive materials and radiation equipment present at CSUF.
5. Manage dosimetry program, issue personnel monitoring devices, and maintain a continuous record of personnel exposure.
6. Provide training for University faculty, staff, students, and ancillary personnel in the safe use, storage, and disposal of radioactive material and radiation equipment.
7. Receive and inspect packages containing radioactive materials.
8. Calibrate portable radiation survey instruments.
9. Process, store, and dispose of radioactive waste.
10. Maintain an organized record of all correspondence, documents, and records pertaining to the radiation safety program.
11. Advise on safe use of radioactive materials and radiation-producing equipment.
12. Respond to radiation emergencies, supervise decontamination procedures, and investigate accidental exposures.
13. Help ensure ALARA is practiced by all participants in the radiation program at CSUF.

F. Authorized User

1. Trained and experienced faculty members that are qualified to supervise the use of radioactive material at CSUF are designated by the Radiation Safety Committee as Authorized Users. Only one Authorized User is allowed to be designated on a RUA permit as the Permit Holder.

G. Non-Faculty Authorized Users

1. In some circumstances, doctorate-level individuals who are qualified by training and experience to use radioactive material, but are not members of the CSUF faculty (e.g., research fellows), may be designated Authorized Users. These individuals may use radioactive material as long as they ensure that all CSUF policies are followed.

H. Students

1. Students may work with radioactive material under the guidance of an Authorized User. The Authorized User must notify the RSO before students are permitted to work with radioactive material.
2. Students are authorized to use only specific radioactive materials as defined in the permit application once the required training is completed. See Section II, Part G: Training and Continuing Education.
3. Notify the Authorized User, RSO or EHS of any unsafe practices, including any accident or incident involving or suspected of involving radioactive material or radiation-producing devices.

I. Achieving ALARA

ALARA is an acronym for ***As Low As Reasonably Achievable***, which is a 10 CFR 20 requirement for “making every reasonable effort to maintain exposure to radiation as far below the dose limits ... as is practical.” This requirement obligates the RSO to conduct the safety program in such a way as to minimize radiation exposure to personnel. For current dose limits, see Appendix 2 section of this manual.

J. Achieving ALARA: Basic Principals

ALARA cannot be achieved by the actions of the RSO alone. This program requires that all participants use basic radiation safety principals (such as time, distance, and shielding) and conduct frequent monitoring of all work areas to minimize exposure. Radiation safety training will be provided to all Users and Ancillary personnel prior to the use, before working in the vicinity of Radioactive Materials and at refresher trainings. Any questions about the ALARA program should be directed to the RSO.

K. Reproductive Health Policy / Pregnant Workers

In keeping with the regulations as set forth in 10 CFR 20, it shall be the policy of CSUF to limit radiation exposure of every pregnant student or employee to 0.5 rem or less during pregnancy (see Appendix 2 for units and conversions). During pregnancy, a woman working with radiation should wear a special fetal monitoring badge. To obtain this badge, a woman must sign a “Declaration of Pregnancy” form and submit it to the RSO as soon as she learns that she is pregnant. Although it is strongly encouraged, it is not required that a woman “declare” her pregnancy. Additionally,

once a pregnancy is declared, it may also be “undeclared” at any time and the person resumes the exposure limits of a regular radiation worker. Refer to the Reproductive Hazards and the Pregnant Worker document or contact EHS for additional information.

II. Radiation Use Authorizations (RUA)

A. Who needs one?

Any faculty or staff members who intend to work with radioactive material or ionizing radiation-producing equipment must submit an RUA request. This form is to be completed and submitted to the RSO, who will in turn present it to the RSC along with recommendations.

B. Qualifications

The RHB requires that users have specific qualification in order to obtain an RUA. Individuals who are proposed as independent users or who will supervise use of sources of radiation by others must have the following minimum qualifications:

1. A college degree or an equivalent in the physical or biological sciences or engineering.
2. At least 40 hours of training or practical experience in the characteristics of ionizing radiation and its radiation dose quantities, radiation detection instrumentation, and biological hazards of exposure to radiation appropriate to the types and forms of radiation sources to be used.
3. A Statement of Training and Experience must also be completed and submitted with the RUA Request.

C. RUA Approval

Approval of the RUA is contingent upon a review by the Committee of the RUA Request, the Statement of Training and Experience, and a safety review of the proposed use. Final approval comes from the RSC. The RSO will notify the applicant of the approval.

D. User's Responsibilities

Persons holding RUAs (the User) are expected to have read and understood the Radiation Safety Manual and specific terms of his or her RUA. All regulations concerning the use of ionizing radiation will be followed. Anyone working under the supervision of a User is the responsibility of the User and is required to follow the same rules as defined by the User's RUA, the University license and Radiation Safety Manual. It is also the responsibility of the User to keep their exposures, as well as

those who work under their supervision, as low as reasonably achievable (ALARA requirements) and below the permissible exposures listed in Appendix 2.

Every year, each User must complete some form of Continuing Education. Usually the RSO reviews the RUA with the User to complete this requirement. However, training received off-campus could apply to this annual requirement. Check with the RSO to see if training received off-campus can apply.

E. Starting Up

Before any radioactive material or ionizing radiation-producing equipment can be received by the User, the area where these items are used must be prepared and approved by the RSO. Signs, waste containers (where appropriate) and all protective equipment shall be in place before any radioactive material or radiation-producing equipment enters the User's area(s).

All Users will receive copies of the Radiation Safety Manual and all pertinent forms for maintenance of their RUA. Copies of all forms can be found on the EHS website.

F. Program Violations and Disciplinary Action

Compliance with regulations and campus policies regarding all radioactive material and radiation-producing equipment is expected from all Authorized Users. Non-compliance to these rules requires the following procedures:

1. The RSO will discuss the non-compliance issues with the Authorized User and dictate a timeline for compliance.
2. Repeated non-compliance can result in the withholding of any future radioactive shipments until compliance is achieved.
3. Continued non-compliance will result in the notification to the RSC, the User and the User's Department Chair that, if the RSC deems this action necessary, the RSO can take possession of all radioactive material.
4. During the next six months, the User must meet with the RSO to determine future actions that are necessary to bring his or her Authorization back into compliance and how those actions must be continued in order to maintain that Authorization. This agreement must be in writing and approved by the RSO and the RSC.
5. If no action is made by the User in six months, the User will be denied any future Authorizations until the User writes a complete action plan for compliance and appeals to the RSC and the RSO for approval.
6. All documentation of these actions must be held in the Radiation Safety files and reported in all RSC reports.

G. Training and Continuing Education

1. Basic Training

All persons using ionizing radiation or working in areas where ionizing radiation is used, shall receive basic training from the RSO. These persons include all Users, faculty, staff, students, and ancillary personnel. Basic training shall include but is not be limited to the following:

- a. Annual dose limits
- b. Identification of use areas
- c. Potential hazards
- d. Pregnancy policy
- e. Current regulations
- f. License conditions
- g. Duty to report unsafe condition

The RSO or designated representative schedules Radiation Safety orientation training for all Users and Ancillary personnel prior to use and before working in the vicinity of Radioactive Materials. RUA Principal Investigators are to notify potential new users or ancillary personnel of the required radiation safety training and to have them contact the RSO at x7233.

2. Additional Training for Users

The RSO will explain particular aspects of the University's license as it applies to the User's work. The approved RUA will be reviewed in detail and all applicable forms will be disseminated.

3. Refresher Training

Refresher training shall be provided initial and as-needed to all persons working with ionizing radiation. The RSO or designated representative schedules annual Radiation Safety refresher trainings for Users and Ancillary personnel.

4. Visiting Researcher Training

Visiting researchers who will be working with radioactive material must complete online radiation safety training and receive Basic Training from the RSO. Visitors must be listed on the RUA's approved personnel list.

5. Training Documentation

CSUF will maintain training documentation for inspections.

H. Changing or Terminating RUAs

1. Changing the RUA

Changes to the RUA must be documented and approved by the RSO before they take place. These changes include the addition of a radionuclide, the quantity ordered, or the addition of personnel. Major changes, as determined by the RSO, must also be approved by the RSC. These changes include room changes, considerable changes in an experiment, or the addition of radionuclides that have extraordinary hazards associated with them.

2. Inactivation of the RUA

If work with radioactive material temporarily ceases, the RUA can be inactivated. If no radioactive material remains on the inventory, the area can be decommissioned by a wipe test (for liquid and solid radioactive sources). If radioactive material is still stored in the area, a wipe test will be performed on the area; the radioactive material will be placed in a secure, designated location. Quarterly wipe tests will continue to be performed in storage areas. No use of radioactive material can resume until the RSO has been notified and the re-activation of the RUA has been approved by the RSO and/or RSC. Radiation-producing equipment will be locked while not in use.

3. Termination of the RUA

RUAs must be terminated when work with radiation ceases. Disposal of all radioactive material or equipment must be coordinated with the RSO. Wipe tests (if appropriate) must be conducted and the area declared “clean” (not more than 2X background). All signs and waste containers with the Radioactive word or symbol will be removed by the RSO or delegate.

4. Leaving the University

It is the User’s responsibility to ensure that all issues concerning radioactive materials, radiation-producing equipment, their use and disposal are cleared before leaving the University. Additionally, the RSO must be notified IN ADVANCE so that all equipment and areas on that person’s RUA can be tested and decontaminated, if necessary, before the User has left the University.

III. Personnel Monitoring and Dosimetry

A. Who is monitored?

Any person who is working in areas where ionizing radiation is produced by gamma or X-ray sources, or emits beta particles with energies greater than 760 keV must wear a dosimeter (see Appendix 2 for units and conversions). The term “badge” can indicate either a body or a finger dosimeter. The type of badge worn will be determined by the type of ionizing radiation present. The RSO will help one decide which is best for the situation. Additionally, pregnant women working in areas where ionizing radiation is used are monitored with a special fetal monitoring dosimeter.

B. Exposure - Regulatory limits

The annual limit for an individual is a total effective dose equivalent of 5 rem (0.05 Sv). The annual limits to the lens of the eye is a dose equivalent of 15 rem (0.15 Sv), and a shallow dose equivalent of 50 rem to the skin and any extremity (see the Appendix for units and conversions). Anyone under the age of 18 has an annual limit of 10% of those exposures described above.

C. How to wear a badge

Personnel monitoring badges should be worn at the position on the body where the exposure is potentially the most critical. Therefore, body badges should be worn on the torso upper chest level, with the name tag facing toward the source of radiation. Finger badges should be worn on the hand closest to the radioactive source, with the text side facing the inside of the palm. Do not expose badges to direct sunlight or moisture. Report lost or damaged badges immediately to EHS.

D. How to order a badge

Requests for personnel monitoring badges are made through the RSO or delegate. A Radiation Training/Badge Request form must be completed to order a badge. Usually this is completed at the time the person completes the Radiation Safety Training course. It takes several days to receive the badge after the request has been received, so allow at least two weeks for delivery. When ready, the badge will be placed on the Dosimeter Rack in the appropriate work area of the wearer.

E. Requests for exposure history

Records of exposure are confidential information. However, it is the right of the individual to review their exposure history at any time. To ensure that the records for the limits of exposure are kept, CSUF will request a previous exposure history from previous employers. Similarly, future employers may request exposure histories for personnel who were in the dosimetry program while at CSUF.

F. Scans and Bioassays

Scans of the thyroid are performed when experiments are conducted using unbound iodine in quantities equal to or exceeding 0.12 microcuries. Scans are done before and after each experiment with unbound iodine and recorded by the RSO.

Bioassays are performed in the case where large amounts (greater than 1 millicurie) of tritium (H-3) are used, or in cases of suspected accidental exposure. For use of these quantities, urine analysis will be conducted weekly under the guidance of the RSO and recorded by the RSO.

For accidents and any other suspected exposures, bioassays or whole-body counting will be determined and directed by the RSO or delegate.

G. Participation of Minors (Persons under 18 years)

Regulations concerning minors require that annual exposure levels be kept to a maximum of 10% of an adult's limits. Therefore, the access of minors in radiation areas must be restricted. Additionally, a "Consent to Participate" form must be signed by the parent or guardian.

IV. Receipt of Material and Machines

A. Ordering of Material and Machines

1. Ordering

All orders of radioactive material or radiation-producing equipment must be approved by the RSO, or designated representative, before any order can be placed. Approvals are marked with a stamp and signature from the RSO (or designated representative) on the Purchase Requisition.

Environmental Health and Safety (EHS) staff must be notified of the arrival date of radioactive material to ensure that personnel are available to receive and check in the material. Schedule all deliveries during normal business hours and on days when the university is open.

Detailed Standard Operating Procedures for the Ordering and Receipt of Materials and Machines may be obtained from the RSO.

2. Check in and receipt

Shipping and Receiving staff will log in the material and secure it in a locked cage.

EHS staff will take possession of the material from Shipping and Receiving. EHS staff will check the packaging and material for leaks, record the receipt of the material, and deliver the material to the User with its respective Inventory Sheet. Each vial of material will have its own Inventory Sheet and unique inventory number.

X-ray equipment shall be tested for leaks during the highest energy level of expected operation before that equipment is used for experiments.

Detailed Standard Operating Procedures for Radioactive Material Package Receipt may be obtained from the RSO.

B. Transfer and Transportation of Material or Machines

1. On Campus

Liquid radioactive materials are of the greatest concern when moving them from one location to another. Transportation must include a stable cart (if the item is large), and a double containment system. Placing a vial inside a sealed plastic container is a good example. Also, material transferred from one RUA to another requires:

- a. Approval of the RSO, and
- b. Completion of the Radioactive Material Inventory Log Sheet

2. Off and On Campus

Items can only be delivered to campus via a regulated carrier. Some situations allow Users to transport small quantities of radioactive material. Users must notify and get approval from the RSO before any transportation of material takes place either from the building or off campus. If materials are to be shipped off campus please contact the RSO or delegate and note that the following must be verified:

- a. Verify that the recipient of the RAM has a RML (if applicable)
- b. Verify the shipper has the required DOT training
- c. Commitment to follow all applicable DOT regulations.

C. Storage and Security

These guidelines shall be followed when choosing a place to store radioactive materials:

1. Areas must be locked when unattended.
2. Refrigerators, cabinets, and freezer must have a Radioactive Materials sticker on the outside.
3. A Radioactive Materials or Ionizing Radiation sticker or sign must be posted on the outside of each room where radioactive material is stored or used.
4. No food or drink may be stored or consumed where radioactive materials are stored or used.

V. Disposal of Radioactive Materials

A. Procedures

The RHB requires that the University keep track of all of their radioactive waste. This requires a concerted, conscientious effort. The RSO must keep accurate records, but this also depends upon Users and their staff and students to provide accurate waste information. All waste must be labeled with the nuclide, quantity, date disposed and name of generator.

Transportation of Radioactive waste on campus is done only by the RSO or EHS staff. To order a waste pick-up, contact EHS to report the nature of the waste and its location. A waste flow sheet must be attached to the container before it can be picked up.

B. Liquid (Aqueous) Waste

Liquid radioactive waste must be placed in carboys (5 to 20 liter plastic containers) provided by the RSO or delegate. **NO ORGANIC COMPOUNDS CAN BE PLACED IN THESE CARBOYS.** Any biological waste which is mixed in with the radioactive waste must be inactivated with bleach (sodium hypochlorite) before being placed in the carboys.

C. Solid Waste

All solid waste must be placed in plastic containers supplied by the RSO or delegate. **NO LIQUID CAN GO INTO THE SOLID WASTE CONTAINERS.** Make every effort to extract as much liquid from the bottom of tubes before disposal of the tubes. Any extraordinary or unusual items (other than the usual gloves, paper, and pipette tips) must be noted on the Waste Flow Sheet.

D. Sharps Waste

Sharps waste is special solid waste. All sharps (syringes, Pasteur pipettes, scalpels, etc.) must be placed in special cardboard or other rigid containers supplied by the RSO or delegate. It is not necessary to classify plastic pipette tips as sharps waste. **DO NOT PUT SHARPS IN WITH THE REGULAR SOLID WASTE.**

E. Liquid Scintillation Cocktail or any organic liquid waste

Vials containing Liquid Scintillation Cocktail must be placed in the drum in the DBH-161D fume hood for disposal. The vials are placed in the drum still capped. **DO NOT OPEN THE VIALS.** Make sure that the Flow Sheet on the drum is filled out and the name or type of scintillation cocktail is noted.

All other organic waste must be dealt with on a case by case basis by the RSO. Call the RSO for specific instructions.

F. Animal carcasses

Animal carcasses as well as smaller pieces of animal tissue are placed in plastic bags for disposal. Label the outside of the bag with the nuclide, amount, date and User's name. Contact the RSO or EHS for pick-up of the carcasses.

G. Radioactive material Inventory

Individual users must maintain records of receipt and disposal of their materials and equipment at all times. The records of these materials are kept by the RSO and are sent to the Users twice a year to update inventories. It is the responsibility of the User to ensure that the records are correct and kept up to date.

H. Decay-in-Storage

Waste material may be held to decay-in-storage at the CSUF waste facility. The following criteria must be met prior to releasing the material for disposal:

1. The waste must be held in storage until the radiation exposure rate cannot be distinguished from background radiation levels.
2. The waste must be monitored at the container's surface and with no interposed shielding.
3. The waste must be monitored with an appropriate radiation detection instrument set at its most sensitive scale.
4. The licensee must obliterate or remove all radiation labels.
5. Records of the disposal are maintained.

I. Naturally-occurring Radioactive Materials (NORM)

1. Definition and Use

NORM is a term used to define naturally occurring radioactive materials that may have experienced some kind of technological enhancement. Human activity can enhance NORM so that its composition, concentration, availability, or proximity to people is altered. The term NORM is used when the naturally occurring radionuclide present is in sufficient quantities to require radiological protection to the public or the environment. The depleted uranium present in uranyl acetate is an example of NORM.

2. Disposal

NORM waste is considered radioactive waste and is subject to the same regulations as all other types of radioactive waste. Containers must be clearly labeled with the chemical name, lab room number, and person generating the waste. Contact the RSO for pick-up of NORM waste.

VI. Procedures and Equipment

A. Animal Use Rules

1. Work Area

Work with animals must be conducted in a secure area. The entrance to the work area must be clearly posted with a Radioactive Materials sign and locked at all times. The area must be lined with absorbent paper where practical and monitored upon exit from each phase of an experiment.

Upon completion of the experiment, the area will be wipe-tested by the RSO or EHS staff and certified as “clean” or non-contaminated before the area can be released for other work.

2. Waste Handling

All waste will be handled as described in the Waste Procedures.

3. Prior approval

Work with animals must be a part of the User’s RUA, as approved by the RSC. Additional approval must be granted by the Institutional Animal Care and Use Committee.

B. Radiation Work Areas

1. Designation

All areas where ionizing radiation is present must be marked with signs bearing the “Radioactive” symbol and the specific hazard (i.e., Radioactive Materials, X-rays, etc.)

2. Inspections

The RSO shall inspect areas used for ionizing radiation and radiation-producing machines on an on-going basis. Problems or concerns will be discussed immediately with the Users. Formal annual inspections will be performed by the RSO and subsequently reviewed by the Users.

C. Lab Safety Rules

1. General Guidelines

It is important to maintain good work habits and safe laboratory techniques. Good science comes from controlled, well-managed procedures. The following procedures should apply to any area where hazardous materials are used or stored, but they especially apply to work with radioactive material or sources:

- a. All work areas and equipment must be clearly labeled with radiation warning signs.
 - b. If required, always wear the personnel monitoring badge while working with or around radioactive material or radiation-producing devices.
 - c. No eating, drinking or applying cosmetics (especially lip or eye products) in the work areas.
2. Specific rules for unsealed sources (liquids, solids)
- a. No mouth-pipetting of any liquid is permitted - no exceptions.
 - b. Equipment used in radiation work areas shall not leave that area until wipe-tested and determined to be free of contamination.
 - c. Bench paper must be placed (absorbent side up) in the work areas.
 - d. Use mechanical devices or remote handling devices when appropriate to reduce exposure to extremities.
 - e. Practice new techniques without radioactive material before conducting the actual experiment.
 - f. Use trays under work areas where liquids could spill beyond the absorbent paper.
 - g. Move materials between areas in sealed containers to prevent spillage.
 - h. Survey work areas and hands often while working with radioactive material, but especially before leaving the work area.
 - i. Always wear a lab coat, impermeable gloves and eye protection when working with radioactive material. Dispose of used gloves in the appropriate radioactive solid waste container.
 - j. Work with volatile substances, such as isotopes of Iodine, must be performed in an approved fume hood.
 - k. Wash hands before leaving the work area.
3. Specific rules for sealed sources
- a. Store sources in clearly marked containers.

- b. Sources must be accounted for after each use and returned to their storage containers.
 - c. Some sources require periodic leak testing. Check with the RSO to determine which sources must be tested.
4. Specific rules for x-ray units
- a. Enter the Start and Stop times in the machine's User's Log every time you operate the x-ray unit.
 - b. Check for stray x-rays any time adjustments are made to the unit. Document the results in the User's Log.
 - c. X-ray units must be clearly marked with radiation warning signs.
 - d. The safety override key must be stored in a secure location and must not be left in the unit.
5. Appropriate Apparel; Personal Protective Equipment (PPE)

Persons working with removable (unsealed) radioactive material must wear lab coats, gloves, and eye protection. Shoes must cover the entire foot and preferably made of non-permeable fabric (i.e., leather). Shorts can be worn provided the lab coat is sufficiently long enough to cover the leg down to the knee and buttons down to the bottom button.

D. Labeling

1. Description

Areas where ionizing radiation or radiation-producing equipment is present must have warning placards on all the entrances to the areas.

All work areas, equipment, containers, storage units and any other devices that could potentially be contaminated with or contain radioactive material must be labeled with the standard radiation trefoil signs or labels.

All radioactive material that is transferred from the original shipping container must be placed in a secondary container with radioactive tape and the radionuclide, quantity, and date marked on it.

2. Restrictions

It is unlawful to place radiation warning signs where radiation does not exist.

E. Routine Surveys

1. Types

There are two basic types of surveys that are conducted to detect the presence of radioactive contamination. One is performed by the Survey Meter, which is commonly called a Geiger Counter. This type of survey is used for gamma-emitting and middle-to-high energy Beta-emitting nuclides (150 keV or greater) and X-rays. Surveys with these meters must be employed with very slow movements close to the areas or items being surveyed.

The second type of survey is the wipe test that is analyzed in a Liquid Scintillation Counter (LSC). It is the ONLY method used to survey for H-3, but it can be used for any nuclide.

2. Requirements of the Principal Investigator (PI)

a. Weekly

It is the responsibility of the PI that surveys of radiation work areas are conducted every week that work with radioactive material has been conducted. These surveys must be documented in the User's Log.

b. Daily

Surveys of the person and the work area must be conducted at the end of every day that radioactive material is used. It is good lab practice to survey frequently during the day, especially when leaving the work area. These surveys do not have to be recorded unless contamination is found.

3. Surveys by EHS Staff

Wipe tests and/or surveys of work areas are conducted regularly by EHS staff. The frequency of the surveys (weekly or quarterly) is dependent upon the type of work conducted in the area. The frequency will be determined by the RSO.

F. Equipment

1. Types

When possible and appropriate, survey meters will be issued to PIs. They are the property of the RSO, but are loaned out to Users. Any cost incurred because of damage to the meters is the responsibility of the PI. Regular maintenance and repair is the responsibility of the RSO.

2. Calibration

Regardless of ownership, the RSO will calibrate all meters annually. Calibration data will be clearly marked on stickers on the meter and, where applicable, the probe. Meters that cannot be adjusted within acceptable response ranges will be taken out of service and repaired. Survey instruments will be calibrated following repair.

VII. Emergencies: Spills and Exposures

A. Emergencies

In an emergency, stop and assess the situation. Know what the emergency procedures are for your work area, and decide what you are capable of doing. Always notify your supervisor, the RSO, and (after hours) the CSUF Police Department.

1. Injuries

In situations involving injury with liquid or solid radioactive material, the injury should take priority. Isolate the area to prevent the spread of contamination, keep the injured person in the work area, and make sure that emergency personnel know that radioactive materials are present. All injuries must be documented, no matter how minor. If the injured person is taken to the University's Student Health Center, the paperwork will automatically be filled out. If the injured person does not go to the Health Center, it is the responsibility of the supervisor to make sure that the Injury Form is completed. Forms are available from the RSO or the EHS website.

2. Spills

Spills of radioactive liquids or solids must be cleaned up immediately. Small spills are often absorbed onto the absorbent bench paper. The contaminated bench paper can then be cut out and placed into the solid radioactive waste container. Larger spills must be handled with more care. Large volumes of liquid can splash great distances away from the spill and easily seep into cracks between benches or tiles. If a spill involves splashing onto an individual, keep the contaminated person inside the work area. All spills, regardless of size, are taken seriously and are treated the same way:

- a. Isolate the spill area. Do not allow traffic through the spill area until the area has been thoroughly decontaminated. Post signs to alert others of the spill.
- b. Ask for assistance, if necessary. Ask others to help you isolate the area and seek help if you need it. If you are alone, carefully leave the spill area to minimize spreading contamination then call the RSO for assistance. After hours, or if the RSO cannot be immediately reached, call the CSUF Police Department and report the situation. They will contact the RSO.

- c. If equipment has been contaminated during a spill, make sure the equipment is clearly labeled to alert others that contamination is present.
- d. Spills with appreciable amount of liquid should be cleaned up with paper towels. Wring out the moisture from the towels as much as possible into the liquid radioactive waste carboy, and then put the towels into the solid radioactive waste containers. **DO NOT PLACE DRIPPING-WET PAPER TOWELS INTO THE SOLID RADIOACTIVE WASTE CONTAINERS.** Drain all excess moisture into the liquid waste carboys, if possible.
- e. **IN ALL SITUATIONS, notify the RSO of the spill.** The RSO will assist in assessing the situation and will perform a final survey of the area to verify that it has been thoroughly decontaminated.

3. Exposures

Accidental exposures can occur in several ways: inhalation, ingestion, direct skin contact, and by gamma radiation or X-rays. Make sure you are familiar with all of the radioactive materials and the other hazardous materials with which you are working so that you can best describe your injury and potential exposure to emergency personnel.

For external skin exposures (such as a splash from a liquid), immediately rinse the affected area with copious amounts of water. Rinse for several minutes, and then wash thoroughly with soap. Notify your supervisor and the RSO to assess the treatment. A contamination assessment of the sink that was used to rinse the exposed area will also be performed.

Exposure from inhalation, ingestion, gamma emitters, and X-rays are all handled differently. Contact your supervisor and the RSO, and then seek medical attention immediately.

4. Phone numbers:

PERSONNEL AND OFFICES	PHONE
Radiation Safety Officer	657-278-4429
CSUF Police Department (non-emergency)	657-278-2515
Emergencies (from Campus Phones or Cell phones)	911*
Environmental Health & Safety (EHS)	657-278-7233
Regional Radiologic Health Branch, Brea (RAM unit)	714-524-1409
Regional Radiologic Health Branch, Brea (X-ray unit)	714-524-5681
California Department of Public Health, Radiologic Health Branch, Sacramento	916-327-5106

*NOTE: Use campus phones for all emergencies on campus. "911" calls from campus phones will go directly to the CSUF Police Department. "911" calls using a cell phone on campus will connect you to the CSUF Police Department, but if you reach another response agency, please ask them to forward your call to the CSUF Police Department.

Responsible Executive: Vice President for Administration and Finance

Responsible Office: Environmental Health and Safety

Originally Issued: 3/2002

Revised: 7/2005, 1/2008, 10/2009, 3/2010, 1/2012, 12/2018, 10/2022

Appendix 1 to Radiation Safety Manual

Definitions

10 CFR 20 - Title 10 (Energy) of the Code of Federal Regulations, Chapter 1 (Nuclear Regulatory Commission), Part 20 (Standards for Protection Against Radiation). Its purpose is to establish standards for protection against ionizing radiation resulting from activities conducted under licenses issued by the Nuclear Regulatory Commission. It guides the receipt, possession, use transfer and disposal of licensed material. These regulations are the “heart” of any radiation safety program.

Agreement State - California is an Agreement State, which means that the NRC has designated the California Department of Public Health-RHB as the agency to issue licenses to institutions or individuals in the state, under NRC guidelines.

ALARA - As Low As Reasonably Achievable. This is the hallmark of our program that guides all of our actions with radioactive material or equipment.

Broad Scope License - The type of license issued to California State University, Fullerton by the State of California DPH-RHB. It describes the types, amounts, locations and uses allowed on campus, as well as the person(s) responsible for administering the license.

CPM - Count per minute. The amount of radioactivity, as measured by some instrument. CPMs cannot be directly calculated to a Unit of measure (such as a Curie or Becquerel) without knowing the efficiency of the instrument.

DPH - Department of Public Health

DPM - Disintegrations per minute. The amount of radioactivity that can be calculated into a Unit of measure (such as a Curie or Becquerel). $1 \text{ DPM} = 4.505 \times 10^{-7}$ microcuries. See Appendix 2 for more conversions.

Gray - Symbol Gy; it is the SI unit of absorbed dose. One gray is equal to an absorbed dose of 1 Joule/kilogram (100 rads).

Isotope - Atoms of a single element, but having different numbers of neutrons. Hydrogen, for example, has 2 isotopes: H-2 (deuterium) that is not radioactive and H-3 (tritium) that is radioactive (a radioisotope).

LSC - Liquid Scintillation Counter

NRC - Nuclear Regulatory Commission

PPE - Personal Protective Equipment. Refers to lab coats, eye protection, gloves and covered footwear.

Rad - It is the special unit of absorbed dose. One rad is equal to an absorbed dose of 100 ergs/gram or 0.01 joule/kilogram. (1 rad = 0.01 gray)

Radioisotope - Radioactive atoms of a single element that have different numbers of neutrons. P-32 and P-33 are radioactive isotopes of Phosphorous.

Radionuclide - Any species of radioactive atoms without reference to a particular element. Examples are C-14, H-3, P-32, etc.

REM - Radiation or Roentgen Exposure Man. It is the special unit of any of the quantities expressed as dose equivalent. The dose equivalent in rems is equal to the absorbed dose in rads multiplied by the quality factor (1 rem = 0.01 sievert).

RHB - Radiologic Health Branch

RSC - Radiation Safety Committee

RSO - Radiation Safety Officer

RUA - Radiation Use Authorization

Sievert - Symbol Sv; it is the SI unit of any of the quantities expressed as dose equivalent. The dose equivalent in sieverts is equal to the absorbed dose in grays multiplied by the quality factor (1Sv = 100 rems). The quality factors are listed in 10CFR20, tables 1004(b).1 and 1004(b).2 of Section 20.1004.

TITLE 17 - Title 17 (Public Health) of the California Code of Regulations, Division 1 (Dept. of Health Services), Subchapter 4 (Radiation). These state regulations define the licensing requirements with which institutions must comply to receive a Radioactive Material License.

Appendix 2 to Radiation Safety Manual

Conversion Formulas/Dose Information

<p>Conversions from Curies to Becquerels</p>	<p>Becquerel's are the SI units of radioactivity. 1 Becquerel = 1 disintegration per second (dps). Curies are the historical unit of measure for radioactivity, and still more commonly used. 1 Curie = 3.7×10^{10} dps (or Becquerel's), or 2.22×10^{12} disintegrations per minute (dpm)</p>
<p>Conversions from CPMs to millicuries</p>	<p>CPMs are Counts Per Minute and are dependent upon the counting efficiency of the instrument. For example, if the counting efficiency of the meter is 20% for P-32 and it reads 100 cpm, it means that you are really measuring 500 dpm.</p> <p>Once you know how many dpms there are in your sample, you can use the conversion above to convert to Curies (or microcuries, etc.).</p>
<p>More helpful units</p>	<p>1 millicurie (mCi) = 2.22×10^9 dpm 1 microcurie (uCi) = 2.22×10^6 dpm 1 dpm = 4.505×10^{-10} mCi 1 dpm = 4.505×10^{-7} uCi</p>
<p>Occupational Dose Limits (10CFR20) (Annual Limits)</p>	<p>For Adults: Whole body: total effective dose equivalent: 5 rems (0.05 Sv) Lens of the eye: 15 rems (0.15 Sv) Skin or any extremity: 50 rems (0.5 Sv)</p> <p>For Minors: 1/10 of an adult's limits</p>
<p>The ABG's (Alpha, Beta, Gamma's) of Radioactivity</p>	<p>The nucleus of a radioactive atom disintegrates, or decays, by various methods. The three most encountered in research labs at CSUF are alpha particles, beta particles and gamma rays or photons.</p> <p>Alpha particles: Large (2 protons and 2 neutrons) particles, with a large amount of discrete energy, in MeV. A gamma ray is usually emitted at the same time.</p> <p>Beta particles: Small electron-sized particles, with a range of energies, in keV to MeV. Gamma rays may or may not be emitted with beta decay.</p> <p>Gamma rays: Electromagnetic radiation whose discrete energies range from 0.2 to 1.5 MeV. They are emitted from the nucleus during radioactive decay.</p> <p>X-rays: Electromagnetic radiation has a similar energy range to that of gamma rays. Their difference lies in the fact that X-rays are emitted from outside the nucleus and they can have several energies.</p>