Radiation Safety Manual

Environmental Health & Safety

UC SANTA CRUZ

Radiation Safety Manual
University of California
Santa Cruz

Approval Page
This sheet is maintained separate from the RSM as a record of changes.

RSM Update

October 17, 2024

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Chair, Radiation Safety Committee

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Radiation Safety Officer

Emergency Procedures for Spills of Radioactive Materials

❖ **If the spill is major (> 100 µCi, or involves personal contamination, or involves injury, or is outside the radiation work area):**

1. Call campus dispatch at 911 to contact EH&S. Tell them if you need medical attention or fire assistance.
2. Secure the contaminated area.
3. Wait for EH&S responders.
4. Do not allow personnel to return to work until the area is cleared by the RSO.

While waiting for responders:

- If you are injured (e.g., hand cuts) in the RAD work area, wash the injured area with soap and water, then cover the area with a sterile bandage or clean clothing.
- If eyes are contaminated, rinse eyes at an eye wash for 15 minutes.
- If your clothing is contaminated, remove it immediately.
- If your body is contaminated, wash with soap and water, and put on clean clothing.

❖ **If the spill is minor (< 100 µCi), open your Radiation Safety Spill Kit and use *SWIMS*:**

1. ***S*** – Stop the spill and stop what you're doing (stop your research). Cover the spill with absorbent pads (dampened if spilled material is solid). If your gloves or clothing are contaminated, remove them immediately and place them in a plastic bag. Wear clean clothing, gloves, safety glasses, and a laboratory coat. Wear booties (shoe coverings) if contamination is on the floor.
2. ***W*** – Warn others in the area. They may not be contaminated and need to know.
3. ***I*** – Isolate the area so others don't get contaminated. If the spill is over a large area, use "caution radioactive material" tape and lock the door.
4. ***M*** – Monitor with a Geiger counter (starting with x 0.1 scale) for skin contamination and clothing contamination. Any readings over 2 times background are contaminated; the background levels are in the range of 30 - 40 counts/minutes (CPM). Ask another Radiation User to assist you. Take your time in surveying the hands, shoes, laboratory coat, pants, and face for all contaminated individuals.
5. ***S*** – Survey and cleanup the contaminated area. Do not forget the proper protection equipment, or PPE: gloves, laboratory coat, eye protection, and clean booties before attempting to clean the spill. Use a Geiger counter to determine the perimeter of the spill. Mark the spill area and hot spots with "caution radioactive material" tape. Thoroughly clean by wiping the contamination with absorbent paper (with Scrubbing Bubbles or soap added to a paper towel) working from the outer perimeter towards the center of the spill in one direction.
6. **TO CONCLUDE**, Place contaminated absorbent paper and gloves in a plastic bag, label "caution radioactive", and place it in the respective radioactive waste container. Once finished with the decontamination, survey the area to make sure that it is reading background levels. Take wipe tests. Continue decontamination until wipe tests are less than twice background.
7. Visit the EH&S website (https://ehs.ucsc.edu) and select **Laboratory Incident** to report spills of radioactive materials.

EH&S Contact Information

Radiation Safety Officer (RSO): 831-459-3541
Environmental Health and Safety (EH&S): 831-459-2553 (voice mail), ehs@ucsc.edu

Rev. July 2023, March 2022

RADIATION SAFETY MANUAL

UNIVERSITY OF CALIFORNIA, SANTA CRUZ

FOREWORD

Many research and instruction activities use ionizing radiation as a valuable tool to extend fundamental knowledge and they are an important part of the University's contribution to the society it serves.

The safety record of the University of California, Santa Cruz (UCSC) in its use of ionizing radiation attests to the success of the radiation safety program. Safety standards must continue to be met.

This manual describes the policies and procedures established to ensure radiation safety on this campus. All personnel working with ionizing radiation are required to fully comprehend and follow policies and procedures set forth herein. They must also exercise proper care to prevent radiation from becoming a hazard to themselves or others.

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The use of radioactive materials and radiation producing machines is governed under the California Radiation Control Regulations and the UCSC Broad Scope Radioactive Materials License. The University of California, Santa Cruz is committed to implementing the requirements in its Broad-Scope Radioactive Materials License issued by California Department of Public Health (CDPH). This Radiation Safety Manual supersedes all previous documents and procedures.

Any changes to the policies and procedures included in the Radiation Safety Manual must be approved by the Radiation Safety Committee before implementation. Radiation Users will receive updates from EH&S Radiation Safety when changes have been made.

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1 UCSC RADIATION SAFETY POLICY

The University of California, Santa Cruz (UCSC) has an ethical and legal obligation to establish work practices that provide a safe and healthful environment for students, employees, and the public who participate in official campus activities.

Because of potential hazards involved in the use of radioactive materials and radiation producing machines, the campus administration recognizes the need for a Radiation Safety program. It is the policy of UCSC to implement a Radiation Safety program that maintains the level of exposure to employees, students and the public, "As Low As Reasonably Achievable" (ALARA).

The program is intended to protect personnel from unnecessary radiation exposure, to prevent contamination of our natural resources and to meet the state and federal regulations governing the possession and use of radioisotopes and radiation producing machines.

The Radiation Safety Manual establishes procedures and regulations governing the safe use of sources of radiation at UCSC that conform to the guidelines, standards, and regulations set forth by pertinent sections of the Code of Federal Regulations (CFR) and the California Administrative Code (CAC). See Appendix A for listing of federal and state regulations and statutes.

The Radiation Safety Committee and the Radiation Safety Officer are authorized by the Chancellor to limit, suspend, or revoke an individual's authority to use radioactive material(s) or sources of ionizing radiation if such use is dangerous to the life and health of individuals, or violates health and safety codes.

Every Radiation Use Authorization Holder (RH) and RUA user is provided electronic access to the EH&S website containing the current Radiation Safety Manual (UCSC RSM).

2 ORGANIZATION AND RESPONSIBILITY

For the Radiation Safety Program to function effectively it is necessary that each individual involved understand and perform their responsibilities. These are as follows:

2.1 Chancellor

The Chancellor is responsible for the existence of a radiation safety program that will maintain compliance with relevant local, state, and federal regulations related to the use of ionizing radiation. The Chancellor has delegated responsibility for development/operation of the radiation safety program to the committees, departments, and individuals as stated below.

2.2 Vice Chancellor for Research

The Radiation Safety Committee reports to the Vice Chancellor for Research (VCR) and advises the Chancellor on all matters relating to radiation safety.

The VCR holds a similar role for all research safety committees at UCSC. The VCR has the designated line authority over all users of radioactive materials and radiation producing machines.

2.3 Radiation Safety Committee

The Radiation Safety Committee (RSC) is a body of faculty and other experts appointed by the Vice Chancellor for Research to establish policies and procedures governing the use of ionizing radiation at UCSC, to maintain surveillance over activities involving them, and to report on their status to the VCR. Surveillance activities include the review and approval of use applications and the review of EH&S Radiation Safety operations. The RSC also advises the office of EH&S in carrying out the Radiation Safety Program. The RSC reports to the VCR.

Refer to Appendix B for RSC Bylaws.

2.4 Office of Environmental Health and Safety

The Office of Environmental Health and Safety (EH&S) implements the radiation safety program. This program includes approval and support of all users of radioisotopes and/or radiation producing machines and equipment. Specific functions include monitoring of exposure levels, investigation of incidents, safety consultation, training in radiation safety, radiation safety services, and management of radioactive wastes.

See Appendix E for details.

2.4.1 Director of Environmental Health and Safety

The Director is responsible for the review of UCSC policies on radiation and radiation safety. The director is responsible for reviewing UCSC performance regarding policies and procedures on radiation safety, and ensuring that the university administration is adequately informed of its responsibilities on matters related to radiation safety. The EH&S Director is an ex-officio member of the RSC.

2.4.2 Radiation Safety Officer (RSO)

The RSO is responsible for operation of the radiation safety program and for ensuring that radiation uses are in conformance with UCSC policies and applicable government regulations. The RSO is also responsible for referring to the RSC matters requiring its review and approval. The RSO is an ex-officio member of the RSC.

See Appendix D for details.

2.5 Procurement

The Procurement department is responsible for the acquisition, through established procedures, of all radioactive materials and equipment capable of producing ionizing radiation. EH&S Radiation Safety will assist Procurement in determining if the individual requesting any radioactive material or radiation producing machine is authorized to use and possess it.

2.6 Laboratory Radiation Users

All Radiation Users are trained and qualified in accordance with requirements of Chapter 5 of this manual.

2.6.1 RUA Holder (RH)

The Radiation Use Authorization (RUA) Holder (RH) is the individual who has applied for and received an authorization from the Radiation Safety Committee to use radioactive materials or radiation producing machines. Each RH is responsible for:

- Ensuring that the laboratory environment is safe for use by the Radiation User(s) (RU).
- Identifying an individual (or self) to serve as lab contact.
- Maintaining compliance with local, state, and federal regulations and the Radiation Safety Manual.
- Adhering to the conditions of the Radiation Safety Manual and their Radiation Use Authorization (RUA).
- Providing training to Ancillary Personnel that require radiation safety training to enter the controlled area(s).

Individuals who are proposed as RH must have minimum qualifications as follows:

- Be a faculty member, or professional staff member (academic or staff appointment) of the University of California, Santa Cruz.
- Possess a college degree or an equivalent in the physical or biological sciences or engineering.
- Have 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 exposures to radiation appropriate to the types and forms of radiation sources to be used.

See Appendix F for more details.

2.6.2 Radiation User

The Radiation User (RU) is an individual who is listed as a user on a Radiation Use Authorization. Each RU is responsible for their own safety and the safety of those around them. Each RU is responsible for:

- Keeping radiation exposures ALARA.
- Knowing and observing precautions specified in the Radiation Safety Manual, the radiation safety training they receive, and the specific requirements of the RUA involved.
- Informing the RH and/or RSO of any known unsafe conditions. See Appendix G for details.

2.6.3 Rotational Students

This category includes students who are undergoing quarterly assignment to different research laboratories for familiarization prior to selecting a laboratory for their graduate work at UCSC. These students work under closer supervision than Radiation Users (RU) and are considered "trainees" and not regular members of the laboratory.

Rotational students are not listed on specific RUAs as RU, but do receive all training to work in restricted areas (including hands-on training). Qualifications, training and dosimetry are tracked on a special RUA for Rotational Students.

Upon laboratory assignment, Rotational Students are transferred from the special RUA to RU status under a specific RH. The term of a Rotational Student is a maximum of one year.

2.6.4 Classroom Students

This category includes students for a specific class (or program) who are potentially exposed or may enter restricted areas. These students work under close supervision of Radiation Users. Classroom students are not listed on specific RUAs as RU, but are registered by the RH and receive training specific to their work with radiation. Classroom student assignment as a Radiation user requires specific approval of the RSO and is documented on the RUA.

2.6.5 Minors Working in Laboratories

Minors between the ages of 14-18 years old who wish to work with radioactivity or radiation must be students in an enrolled class involving laboratories, or part of an approved or supervised tour, or have written consent of their parent or guardian and be under the direct supervision of a qualified adult. These restrictions apply to minors who are volunteers or summer interns. RHs must apply to the RSO for exceptions and exceptions must be documented in writing. Minors under the age of 14, including children of laboratory personnel, are not permitted in posted radiation use locations, except when participating in an approved and supervised tour.

2.7 Ancillary Personnel

This category includes those individuals (including UCSC staff, contractors, and unescorted visitors) who are assigned work in radiation-controlled areas (but do not enter restricted areas) and their work does not involve the use of radioactive materials or radiation producing machines (RPM). These workers shall receive a brief training describing safety procedures they are to observe while working in the area. Such work assignments (including visits or tours) may be reviewed and controlled by the RH and/or the RSO. For the purposes of establishing radiation exposure limits, these workers will not be considered occupationally exposed Radiation Users.

3 LICENSING REQUIREMENTS

3.1 UCSC License

The Radiation Safety Program at UCSC is controlled by federal and state regulations. In general, the program applies to all personnel under university auspices who use, supervise, or control radioactive materials, or use RPMs (such as scanning electron microscopes, diffraction x-ray machines, diagnostic x-ray machines, accelerators, or neutron generators) regardless of intensity or quantity.

Under normal circumstances, the best interests of UCSC research are served by allowing each RH the flexibility to establish and implement their own safety requirements; however, projects involving ionizing radiation have regulatory and operational requirements that require formal coordination and a degree of external control. Generally, the RH is aware of important features of radiation control and can appreciate that in the interests of individual and public safety there must be some modification of the traditional academic freedom prevailing in the laboratory.

The RSC has accumulated a large body of experience in dealing with campus radiation matters. In view of the limited dimensions of the real and potential hazards encountered at UCSC facilities, the program of radiation control and the special radiation safety services represent the most satisfactory arrangements for meeting control requirements with available UCSC resources.

When requesting approval to use radiation sources, it is necessary for the applicant to understand the requirements of the Radiation Safety Manual. In all cases, UCSC requirements must meet those specified by governmental regulations but, in some cases they may be more limiting due to the special conditions prevailing upon a university campus. The applicant should know whose responsibility it is to meet these requirements and what assistance may be available to them. Copies of the state regulations, licenses and UCSC policies (including the Radiation Safety Manual) are available from EH&S Radiation Safety.

3.1.1 State Regulation of Radiation Use

The extent and form of restrictions, which apply to each user and facility, are determined by Title 17 of the California Code of Regulations (CCR)[1]. These regulations are based on the federal Nuclear Regulatory Commission regulations that govern the use of certain radioactive materials. The CCR is binding for each person using radioactive materials. Ionizing radiation producing machines are also regulated by the state[2].

3.1.2 State Licensure of UCSC

Both the laboratory researcher and California Department of Public Health (CDPH) Radiologic Health Branch (RHB) are aware of the difficulties inherent in providing a general set of requirements to cover the spectrum of complex situations encountered in research. Therefore, the broadest possible interpretation of these regulations has been provided to the university by means of a "Broad Scope[3]" license for the use of radioactive materials. This license specifies possession limits for radioactive materials and other requirements for the use of these materials at UCSC. Under the terms of this license, the RSC is granted the authority to approve a wide range of applications utilizing radiation, provided it agrees to maintain and enforce the provisions of CCR Title 17 as specified in the UCSC radioactive material license and its associated application. RSC recommendations are implemented by the RSO. **It is important that all users understand that failure to demonstrate reasonable compliance with state regulations in any campus facility could trigger state enforcement action resulting in termination of <u>all</u> licensed use of radiation sources at UCSC.**

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1 California Health & Safety Code Sec. 114960 et seq.

2 Certain radiation producing machines are regulated by a combination of federal and state laws.

3 Broad Scope license is defined at 10 CFR 33

3.1.3 Exempt Sources and Generally Licensed Devices

NRC exemptions and General Licenses[4] permit manufacturers to distribute small amounts of radioactive material[5] to end users without specific licenses. These items include consumer products containing radioactive material (e.g., balances, static eliminators, and smoke detectors). "Exempt Quantities" identified in 17 CCR 30180(c) which might ordinarily be acquired by an individual without a NRC or State of California license, are **NOT** exempt from the requirements of this manual.

The RSO and RSC Chair may grant approvals for specific items installed in the campus physical plant, such as smoke detectors containing Am-241, to be utilized outside of the academic uses covered by the Radiation Safety Manual and the Radioactive Materials License. Exempt and Generally Licensed items of low risk to be used in teaching or research are subject to simplified procedures, analysis and precautions. However, the radiation safety program may track these items to assure the campus is in compliance with the terms of the distribution license (e.g. return to manufacturer requirements) and to verify items are not lost, stolen or destroyed in a manner that could spread radioactivity.

For campus authorizations that consist solely of Exempt or Generally Licensed Devices, the RSO may elect to waive training documentation and listing of authorized users based on the requirements that NRC (or CDPH) has established for exempt or generally licensed distribution to the general public. In these cases, a notice posted on the use location (e.g. microbalance static eliminator) or on the source container will suffice, in lieu of specific training.

3.2 Radiation Use Authorization

A Radiation Use Authorization (RUA) is required before the purchase or use of any (machine or isotopic) source of ionizing radiation.

Application is made appropriate to the type of authorization sought, accompanied by a written standard operating procedure and a completed training and experience form for each person working on the project. The RSO conducts a detailed radiation safety evaluation of the proposed project. Where additional information is required, the RSC may request a meeting with the applicant. Approval is sent in writing and will specify special conditions related to the use such as: special precautions, modes of disposal, purchase procedures, etc.

Recommendations for approval by the RSC of any proposed use of radioactive materials and/or RPM is based on the benefits to be received from the project, the risk/hazard evaluation, and the adequacy of health and safety measures to be employed. Factors considered by the RSC in the evaluation of safety provisions in a proposed usage include experience and ability of the applicant and his or her assistants to cope with hazards involved in the application; adequacy of the facilities and equipment for proposed usage; and the thoroughness and attention given to safety precautions in the proposed experimental procedures and waste disposal methods.

A Hazard Guide Value is assigned, based on quantity per procedure, radioisotope toxicity, and nature of use. The RUA is then classified as Class I, II, or III, depending on the highest Hazard Guide Value. Protocol for assignment of Hazard Guide Value and classification is described in Appendix C.

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[4] Generally licensed material may also be received when a general licensee transfers a generally licensed item to a specific license that is authorized to possess the material. However, when received by the UCSC under this provision, the item shall now be considered as specifically licensed and should be tracked with other specifically licensed material.

[5] NRC determines that the products or types of uses do not constitute an unreasonable risk to the common defense or security or to public health and safety and the environment. Radiation safety features are built into the sealed source or device or the amount of radioactive material that can initially be distributed in such a device is restricted.

3.2.1 Application for Research Use

Radiation User Applicant Training and Experience Statement and Dosimetry Request must be completed for each user for machines or radioisotopes.

For an initial application to use radioactive materials, complete the following:

- Radiation Use Authorization Application - Radioactive Materials or RPM
- *Standard Operating Protocol – Radioactive Materials or RPM* must be completed for each experiment requiring radioactive materials or use of an RPM

3.2.2 Application for Classroom/Instructional Use

An RUA is required for radiation uses in a classroom/instructional environment. RUAs authorizing instructional use of radioactive material or a RPM for teaching or demonstration in courses are issued to the responsible faculty member or professional staff member, who must also meet the qualification for RH. They must submit a *Radiation Use Authorization Application - Radioactive Materials (or RPM),* in addition to the *Radiation User Applicant Training and Experience Statement and Dosimetry Request* for RH and all Radiation Users.

More than one class may be listed on the same RUA, but each experiment must be submitted as a separate protocol using Standard Operating Protocol – Radioactive Materials (or Radiation Producing Machine). The application for a RUA must be submitted to EH&S Radiation Safety for review and approval by the RSC (as required under Level of Review, Table 1) before the commencement of the course.

3.2.3 Student Users

Students participating in the course may be treated as members of the public for exposure limits. At the request of the RH, RUAs may be approved to authorize students to be treated as qualified Radiation Users.
Classroom/instructional students are not listed on the RUA, but a class roster must be maintained of the students working with radioactive materials or RPMs. Students must always work under the direct supervision of a Radiation User (RU) who is listed on the Instructional RUA, and they must receive radiation safety training specific to their planned work as approved by the RSO. Only Radiation Users listed on the RUA will be allowed to supervise the students in the use of ionizing radiation and the proper and safe work practices to prevent unnecessary radiation exposures and contamination incidents. Individuals listed on the RUA must complete all training requirements for Radiation Users.

A separate protocol will be listed with the course number and name for each experiment that incorporates the use of ionizing radiation. The protocol will include:

1. Course number, RUA identifier, and Radiation Users (RU).
2. Description of lab procedures and safety protocols, including:
    a. Health and safety instructions for students (range from read and sign radiation safety training to online Radiation User training)
    b. Radioactive waste disposal procedures for students (if any)
    c. Extent to which students will actually be handling radionuclides or operating an RPM.
    d. Number and type of monitoring instruments available in the laboratory for routine use.

Each time the course is taught, the following information must be provided to the RSO (or posted to the RUA binder) prior to the commencement of the class:

1. Course number and title
2. Laboratory instructor's name and Radiation Users who will be supervising the students
3. Dates of intended use of ionizing radiation
4. Number of students anticipated.

5. A list of students (including names and UC identifier) shall be given to the RSO after the class begins.
6. Radiation Safety shall be notified when the radiation work is completed so a survey (as required by RUA) may be made to verify that the radioactive waste has been disposed of properly.

3.2.4 Presentation in Radiation Protection

A presentation in the principles and practices of radiation protection may be presented to any class using radioactive material. This presentation typically consists of at least 30 minutes of lecture and/or discussion, and may be presented by the instructor, the RSO, or a suitable guest lecturer. This presentation shall be completed before the start of work with radioactive materials in the laboratory. Training for classroom/instructional use where students are classified as qualified Radiation Users is identical to all Radiation Users training.

3.2.5 Termination Survey

After each course finishes radioactive work with unsealed radioactive material, all labels, waste and other radioactive material must be removed, and a termination survey must be performed. The area may then be released for general use. If the radioactive materials are to remain in the area, special arrangements need to be made with the RSO.

3.2.6 Application for Use of Radioactive Materials or RPMs Offsite and/or in the Field

All proposals for use of radiation or radioactive material in the field must be carefully considered and thoroughly reviewed to ensure compliance with all appropriate laws, regulations, and commitments. These reviews must be conducted before requesting an RUA, and the safety analysis must demonstrate how compliance will be achieved.

Use of radiation or radioactive materials in the environment (field) at use locations specified in the Radioactive Material License typically require the RSO notify the CDPH prior to the first utilization. In cases where an RH wishes to use radiation or radioactive material at a location which has not been listed on the Radioactive Materials License, the RSO will have to apply for a license amendment and governmental approval may require several months. Contact the RSO for details.

3.3 RUA Amendments

Amendments to approved RUAs may be requested at any time by making such requests in writing or e-mail to the RSO. Any changes to, or modifications of, an existing RUA must be reviewed and approved before implementation.

Requests for minor RUA amendments may be approved by the RSO provided the amendment does not change the RUA Class, the RH, involve changes in location providing less effective facilities for hazard control, or include the use of new radionuclides. Examples of minor amendments are: reactivation of a discontinued project, use of a new radionuclide for the same procedure, possession limit increase for an existing radionuclide, a change of personnel working on a project, change of location, addition or deletion of rooms, or other changes which do not alter the original authorization substantially.

Requests for significant amendments may require approval of the RSC, depending on the nature and complexity in accordance with the procedures of this manual. The amendment must be approved by the RSC as prescribed in Table 1 Level of Review.

3.4 Review of RUA Applications

The RSC employs the following procedure when reviewing applications for use of radioactive materials:

- All applications are initially submitted to EH&S Radiation Safety.
- The RSO reviews all applications for completeness and prepares them for presentation to the RSC.

- The RSO then conducts a detailed radiation safety evaluation[6] of the proposed project. This evaluation usually includes an interview with the applicant and a visit to the proposed use location(s) to evaluate the adequacy of the facilities.

3.4.1 Technical Proficiency and Vigilance of the Laboratory Personnel

Experience has shown that in radiation work, as in other fields, one cannot expect laboratory work habits and safety performance to improve because of the additional duress presented by potential hazards. Therefore, the proposed project is studied by the RSC to determine that all protective procedures involving radiation hazards are within the field of competency of the investigator. The RSC will, in its assessment, take into account the previous experience and special training of the personnel involved so that the proposed project does not present an unreasonable burden on the user or on EH&S Radiation Safety.

3.4.2 Adequacy of Facilities

Adequate facilities can minimize the potential for operational problems. Items to be considered include:

- Storage facilities
- Engineering controls (e.g., hoods, glove boxes, and other special equipment)
- Personal protective equipment (e.g., gloves, goggles, respirators)
- Housing and maintenance of experimental animals if used
- Impact of radiation use on surrounding areas
- Housekeeping
- Survey instruments

Evidence will be sought to ensure that the RH is familiar with the University Radiation Safety Program, as outlined in this manual, and that they are prepared to institute safety and management controls as required, including:

- Inventory records (receipts, use, transfers and disposal)
- Waste disposal procedures
- Monitoring methods, frequency, and records
- Survey instrumentation, calibration procedures, and records
- Area posting and access control
- Contamination control procedures
- Provision for controlling releases to the environment.
- Personal protective equipment
- Personnel dosimetry and bioassay requirements

All applications are evaluated according to the requirements 17 CCR and conditions in the UCSC radioactive materials license.

Approval of applications is granted by the RSO and the RSC (as necessary) and is sent in writing to the RH with any additional conditions. No work may be conducted until the approval process has been completed.

3.5 Level of Review and Approval

Each RUA application shall be reviewed and approved by the RSC as listed in Table 1.

Any member of the RSC may request a higher level of review for any RUA. RUA Class I are normally reviewed and approved by the RSO. RUA Class II are normally reviewed and approved by the RSO and the RSC

[6] The level or degree of review is tailored in accordance with the risk of the material and proposed use. Generally Licensed and exempt distribution sources receive a limited review,

Chairperson or designee. RUA Class III are reviewed and approved by a majority of individual RSC members or by the RSC in meeting; review techniques shall be determined by the RSC Chairperson. A negative opinion by any member of the RSC consulted requires review of the proposed Authorization by the RSC in meeting. The RSO shall be included in the reviewing body.

Table 1
Level of Review

RUA Class	Minimum RUA Reviewer(s)	
	Approval of Original RUA	Approval of Amendments and Renewals
I	RSO	RSO
II	RSO + 1 RSC Member	RSO + 1 RSC member
III	Quorum of RSC Members	RSO + Quorum of RSC Members

3.6 Determination of the Hazard Guide Value

All applications for radioisotope use are assigned a Hazard Guide Value (HGV). The Hazard Guide Value (HGV) is calculated by the RSO or EH&S radiation safety team using the formula found in Appendix C. This process recognizes that some experimental operations are inherently more hazardous than others by reason of the forces applied, materials used, and the chemical reactions involved.

3.7 RUA Class

The RUA Class assigned to an authorization is based on the calculated HGV for radioactive materials and is designated as either Class I, II, or III by the RSO. For RPMs, Table 2 lists the RUA Class based on the machine type.

Table 2
RUA Class for RPMs

RUA Class	Radiation Producing Machines
I	Scanning Electron Microscope, ion implanters, similar devices
II	Cabinets, XRF, XRD, Medical
III	Accelerators, or so designated

3.8 Laboratory Workplaces

3.8.1 Routine Laboratories

Routine laboratories are campus laboratories with impervious bench tops and floors which meet standard chemical laboratory requirements concerning items such as dilution ventilation, fume hood design, earthquake safety, emergency showers, emergency exits, fire extinguishers and security.

1. Radioactive materials must be stored in suitable refrigerators, freezers, or receptacles and posted with a Caution Radioactive Materials label.
2. Absorbent paper must be used on work surfaces and appropriate waste disposal containers must be available.
3. If volatile materials are used, work must be conducted in a chemical fume hood.
4. The design, construction and equipment of a normal laboratory workplace should be similar to those of a good quality modern chemical laboratory.

3.8.2 Radioisotope Laboratories[7]

Radioisotope workplaces with larger quantity use or higher hazard radioactive material may require more engineering controls such as:

1. Impervious floors with one-piece- construction and covered corners to facilitate decontamination.
2. Restricted access to, and use of, the area.
3. Negative air pressure relative to the surrounding areas. Special attention should be given to avoiding the recirculation of air and the dispersion of contamination to other occupied areas.
4. HEPA filters and/or other suitable filters or traps in the exhaust ventilation may be desirable. The surfaces of the hood and the ventilation system should be smooth and made of non-absorbent material that can withstand the chemicals normally used in the hood. The gas, water and electrical outputs should be operated from outside the hood.
5. Automatic fire suppression equipment is desirable.
6. Additional administrative controls as approved by the RSC, such as protective clothing (e.g. shoe covers, one-piece coveralls, etc.), more frequent monitoring, air sampling, and exit or portal contamination monitors could be required.
7. A properly labeled waste container with lid should be available for the collection of low activity waste.
8. A special room or area should be provided for storing radioactive substances.

3.8.3 High Activity Laboratories

High Activity workplaces should be specifically designed, constructed and equipped for handling large quantities of radioactive material in accordance with the specifications and requirements set by the RSC. These laboratories require some or all of the following additional design features in addition to the requirements of a Radioisotope laboratory:

1. Sophisticated access control provisions including security systems with alarms.
2. Clothing change area with lockers and showers.
3. Remote handling equipment such as caves or shielded hot cells with manipulators or robot arms.

7 Adapted from the American Standards Association, Inc. *Design Guide for a Radioisotope Laboratory (Type B).*

4. Glove boxes with additional HEPA filters and/or other suitable filters or trap series with filtration in the general exhaust ventilation.
5. Processes involving risks of air contamination should be carried out in completely enclosed glove boxes or hot cells under negative pressure and provided with filters and transfer boxes.
6. Radioactive substances should be stored only in a special room equipped with suitable shielding and ventilation, and in accordance with the provisions as regards waste storage.
7. High level, shielded, waste collection facilities.
8. Additional radiation safety features and administrative controls as may be required by the RSC.

3.9 Radiation Use Authorization Renewal

Periodically (1-3 years depending on the discretion of the RSO) EH&S Radiation Safety will meet with the RH to review the status of their work with radioactive materials or RPMs. If no changes are needed, the RUA will be renewed as is. If changes are needed, the RSO will work with the RH to amend the RUA to reflect the needed changes. If the RUA is no longer needed, a closeout survey will be conducted. Approval of periodic renewals will be the same as the initial RUA approval noted in Table 1 unless the changes involve a change in RUA Class.

3.10 Registration of Radiation Producing Machines

All machines that produce ionizing radiation (electron microscopes, cabinet X-ray, x-ray fluorescence, x-ray diffraction, x-ray tubes, electron beam devices, and medical human or animal use) must be registered by the RSO with the State of California CDPH in accordance with 17 CCR § 30108 within 30 days of arrival on campus. RHs are responsible for notifying the RSO so that the required registration can be completed. Higher hazard RPMs may require specialized housing and approvals. Notify the RSO at least sixty days prior to acquisition, construction or reconstruction of a room to house:

- Any RPM capable of operating at a potential in excess of 500 kVp;
- Any RPM that operates at a potential in less than 500kVp, but that for other reasons presents a similar radiological hazard.

This activity is coordinated through EH&S Radiation Safety and the RSO must register the “reportable source” with CDPH.

3.11 EH&S Radiation Safety Audits

The frequency of routine radiation safety audits conducted by EH&S Radiation Safety is based on the RUA Class as indicated by Table 3, or as determined necessary by the RSC and/or by the RSO.

Table 3
EH&S Radiation Safety Audit Schedule

RUA Class	Radiation Safety Audit Schedule
I	Semiannual to annual
II	Quarterly
III	Monthly

At the discretion of the RSO, RUAs may be audited more frequently as needed based on performance or, due to specific hazards of the radioisotope use. EH&S Radiation Safety audits are intended to determine if operations are being conducted properly and safely. Specific items checked include:

- Verification that required records are maintained and current.
- Whether lab procedures are available and followed.
- Posting of areas and materials and safety notifications.
- Confirmation that radioisotopes are used in accordance with the conditions of the RUA and RSM.
- A contamination/area survey as appropriate.

In the event that contamination and/or external radiation areas are found, or if other problems are identified, it will be the duty of the RH to take corrective action.

A report of the audit will be kept on file in EH&S Radiation Safety and a copy sent to the RH.

3.11.1 Noncompliance

If items of noncompliance are identified, a report will be issued by EH&S Radiation Safety detailing the noncompliant item(s) in need of correction and the action required. A timetable will be established with a deadline for making corrections. The report is to be reviewed by the RH, and a response given if needed.

If the noted problems are corrected, no further actions will be required. If the problems are not corrected and are cited on the next inspection, a violation as indicated by Table 4 below will be enacted.

Violations or items of non-compliance are classified into three severity levels, Level 1, Level 2, and Level 3. If violations are found, actions that may be taken are geared to these severity levels. The severity levels for violations are derived from NRC regulations and from UCSC's recent safety history.

Chronic noncompliance could result in an administrative review by the RSC and may lead to cancellation of the RUA. Where evaluation by the RSO indicates recurring or chronic problems, continued authorization of the RUA by the RSC may be contingent upon a more extensive monitoring program and additional personnel training.

Table 4
Sanctions for Repeat Noncompliance

Severity Level	1st Offense	2nd Offense	3rd Offense
Level 1	A standard inspection report is issued. A warning is included in the inspection report indicating that a repeat violation will notify the Radiation Safety Committee.	A violation letter accompanies the inspection report indicating that a repeat of the violation will result in suspension of the RUA. The RH's supervisor and the Radiation Safety Committee will be notified.	The RUA is suspended. The RH will have to appear before the RSC to ask for reinstatement of their RUA.
Level 2	A Standard inspection report is issued. A violation letter accompanies the inspection report indicating that a repeat of the violation will trigger a sanction.	RH's supervisor is notified and the Radiation Safety Committee. The RSO and RSC Chair may ask for a meeting with the RH to discuss resolutions.	Suspension of the RUA. Issue addressed at the RSC's next meeting. RH will have to appear before the RSC.
Level 3	Immediate suspension of the RUA. The RH's supervisor is notified and the Radiation Safety Committee. The RH will have to appear before the Radiation Safety Committee to ask for reinstatement once corrective actions have been made.		

In the event of any single serious violation or discovery of unsafe conditions, the RSO shall bring this matter to the attention of the RH. If no corrective action is taken, the RSO has the authority to impose cessation of the operation and/or to confiscate radioactive materials. The RSO shall promptly report all serious instances of non-compliance to the RSC chairperson.

3.11.2 Stop Work Authority

If the RSO at any time is not satisfied with the adequacy of safety and health practices employed in a project, the RSO may require cessation of the project until satisfactory procedures have been adopted. Appeal of such an action may be made at the next scheduled meeting or at a special session of the RSC.

3.12 Authorization Termination Procedures

In the event that any RH (or person working under the supervision of the RH) is found to be willfully and/or negligently violating any of the federal, state, or university regulations governing the use of radioactive materials and/or radiation producing machines, any or all RUAs under that RH may be suspended or revoked by the RSO, with the concurrence of the RSC, and any radioactive materials in his/her possession may be impounded.

An RUA will ordinarily be terminated by EH&S Radiation Safety upon notification that a project has been completed and that no sources of radiation are to be retained by Radiation Users.

Upon termination of the RUA, an accounting of all radioisotopes or radiation producing machines acquired under the RUA must be reported to the RSO. All remaining radioactive materials must be transferred to another active RUA that is authorized for the radionuclides and their quantities or to EH&S Radiation Safety for disposal.

EH&S Radiation Safety shall be notified of the termination of projects using radioisotopes in sufficient time to permit scheduling of the final monitoring of radiation use areas, accounting of the radioisotope inventory, and satisfaction of requirements for personnel monitoring.

3.12.1 Decommissioning of Facilities and Equipment

Once radioactive materials are used in an area, there is the possibility of contamination of surfaces and equipment. Before such areas and equipment can be released for unrestricted use they must be surveyed by EH&S Radiation Safety and, if necessary, decontaminated to background levels. Decontamination is the responsibility of the RH, but EH&S Radiation Safety will provide technical assistance and supervision if necessary.

3.13 Physical Examination Requirements

As a condition of use of radioactive materials and RPMs, the user is expected to agree to submit to physical or medical examination, including bioassay and medical monitoring, that the RSO may deem necessary or as required by regulations to evaluate radiation exposure and protection of health. The RSO may recommend consultation with competent medical representatives; the potentially exposed individual is expected to comply with that recommendation.

3.14 Summary

The requirements summarized above establish a minimum level for radiation control. These requirements are related to regulatory conditions that deal primarily with personnel and environmental exposure or contamination in a general setting. Additional requirements may be established by the RSO and RSC as needed.

4. RADIATION EXPOSURE POLICY

4.1 ALARA Policy

UCSC has a policy to prevent unnecessary radiation exposures to persons and the environment and to reduce all exposures to as low as reasonably achievable (ALARA), in accordance with the recommendation of the National Council on Radiation Protection and Measurements (NCRP), and federal 10 CFR 20.1101 (b) and state regulatory requirements.

4.2 Occupational Dose

Radiation exposure shall be "As Low As Reasonably Achievable" (ALARA), but in no case exceed the dose limits specified below when exposures from external and internal sources are added together:

Table 5
Occupational Dose Limits

Category of Dose Equivalent	Regulatory NRC Limit[8]	UCSC Administrative Guideline[9]
Total Effective Dose Equivalent (TEDE):	5,000 mrem/yr	500 mrem/yr
(Eye) Lens Dose Equivalent (LDE):	15,000 mrem/yr	1,500 mrem/yr
Shallow Dose Equivalent (SDE) Skin or extremities (hands and forearms, feet and ankles):	50,000 mrem/yr	5,000 mrem/yr
Total Organ Dose Equivalent (TODE):	50,000 mrem/yr	5,000 mrem/yr
Minors (individuals <18 years of age):	10% of NRC limit allowed for adult workers	20% of UCSC administrative guideline allowed for adult workers

No RH shall possess, use, or transfer sources of ionizing radiation in such a manner as to cause any individual in a controlled or restricted area to receive an occupational dose more than the NRC limits established in Table 5. All activities conducted in a controlled area shall limit the exposure of non-Radiation Users to the regulatory limits for members of the public (refer to Table 6).

4.3 Public Dose

Public radiation exposure shall be "As Low As Reasonably Achievable" (ALARA), but in no case exceed the limits specified below when exposures from external and internal sources are added together:

[8] Regulatory limits are legal dose equivalent limits in effect that have been adopted by the NRC and/or CDPH.

[9] Administrative guidelines are dose equivalent recommendations for all UCSC personnel which have been adopted by the RSC. These guidelines should not be exceeded in routine operations without prior RSC approval. The administrative guidelines are not intended to be absolute limits but are established in order to provide guidelines for keeping exposures ALARA.

Table 6
Public Dose Limits

Category of Dose Equivalent	Regulatory NRC Limit
Annual Limit/guideline:	100 mrem/yr
Limit/guideline for dose in unrestricted area (public areas) in any one hour	2 mrem

Public exposure limits apply to students involved in educational activities (not otherwise qualified as Radiation Users), "non-occupational" exposed staff and members of the public.

4.4 Prenatal Radiation Exposure Policy

4.4.1 Federal and State Regulations

Federal and state dose limits and monitoring requirements for declared pregnant workers are as follows:

- The dose to an embryo/fetus during the entire pregnancy, due to occupational exposure of a declared pregnant worker, does not exceed 500 millirems (5 mSv) per gestation period, delivered at a recommended rate of approximately 50 millirems per month or less. Declaration of pregnancy is optional and, if elected, must be done in writing to the Radiation Safety Officer.
- A declared pregnant worker is required to be monitored for doses from external exposure if they are likely to receive, while pregnant, a deep-dose equivalent of greater than 50 millirems per year.
- A declared pregnant worker is required to be monitored for doses from internal exposure if they are likely to receive, while pregnant, a committed effective dose equivalent (CEDE) of greater than 50 millirems per year, or a dose to the embryo/fetus of greater than 50 millirems per year form radionuclides in the embryo/fetus and in the declared pregnant worker.
- If a pregnant individual chooses not to become a declared pregnant worker, the appropriate dose limits and monitoring procedures apply based on their status as an adult or minor.

Table 7
Declared pregnant worker Dose Limits

Category of Dose Equivalent	Regulatory NRC Limit
Gestational Period:	500 mrem
Total per Month:	50 mrem/month

4.4.2 Exposure of Pregnant Worker

Federal and state regulatory agencies have established the category of declared pregnant worker in order to address two competing objectives of national policy. These objectives are:

- The desire to establish a legal mechanism to offer special protection to the developing embryo/fetus by limiting external and internal doses.

- Compliance with a U.S. Supreme Court Decision that prohibits the establishment of mandatory legal dose limits for women that are lower than the legal dose limits for men.

Therefore, each person must choose to become a declared pregnant worker if they want to have voluntary lower legal dose limits for the exposure of the developing embryo/fetus.

UCSC procedures establish administrative criteria for external and internal dosimetry for declared pregnant workers that are often lower (e.g., for penetrating gamma radiation emitters and most internal exposures) than those established for adults who are not declared pregnant workers.

4.4.3 Specific Information for Current or Prospective Pregnant Workers

It is UCSC's policy to inform Radiation Users (employees and students) who may become pregnant of:

- The risks to the developing embryo/fetus from exposures to ionizing radiation.
- The options available to maintain such exposures as low as reasonably achievable below the in-utero legal limit of 500 millirems (for declared pregnant workers) during pregnancy for external and internal exposures.

All Radiation Users are strongly encouraged to contact the EH&S Office if they have any questions regarding radiation exposures during pregnancy.

4.4.4 Special Precautions for Current or Prospective Pregnant Workers

Precautions required or recommended for Radiation Users who are currently or intend to become pregnant and who choose to continue working with or around radioactive materials and/or radiation-producing equipment, include:

- The EH&S Office may issue a radiation dosimeter to a declared pregnant worker to be used as a "fetal monitor" to assess penetrating radiation exposures (from external sources) to the pregnant worker's abdomen upon request.
- If the deep dose equivalent to the embryo/fetus of a declared pregnant worker equals or exceeds 50 millirems per month for more than two consecutive months of a pregnancy, the pregnant worker's work will usually be reviewed to determine if restrictions are necessary to reduce further exposures during the remainder of the pregnancy.
- If the dose equivalent to the embryo/fetus of a declared pregnant worker exceeds 500 millirems during the pregnancy, the pregnant worker will normally be required to avoid all further occupational and educational radiation exposure until after the birth of the baby.
- The pregnant worker should avoid working with volatile or reactive radiochemicals that could result in the inhalation, ingestion, or absorption of radioactive materials through the skin. These procedures should continue to be avoided after the pregnancy if the worker is nursing the baby.
- In any case of suspected accidental exposure to radiation sources or uptake of radioactive materials, the pregnant worker should contact the EH&S Office immediately.

4.5 Personnel Monitoring

The following defines those conditions that require personnel monitoring with dosimetry.

4.5.1 Requirements

Personnel monitoring is required, per 10 CFR 20.1502, for adults, minors or declared pregnant workers likely to receive doses from external sources in excess of ten percent (10%) of their respective NRC limits, or by individuals entering a high radiation or very high radiation area. Personnel monitoring

devices are devices worn or carried by an individual for the purpose of measuring the dose received. Examples include thermoluminescent dosimeters (TLD), or electronic exposure rate dosimeters.

Dosimeters should be stored away from excessive heat and in a low "background" radiation area when not being used.

Whole body monitoring of external radiation exposure is usually by TLD badges that are changed three times a year. The RSO may designate shorter wear periods if needed. The new badges are sent to the RH for all Radiation Users. **Extremity monitoring** is provided, in addition to whole body monitors, when the extremity exposure is likely to be greater than 10 times the whole-body exposure or at the discretion of the RSO.

4.5.2 Supplementary Dosimetry

If the RSO determines that it would be helpful to have supplemental dosimetry to further define a radiation exposure, additional dosimetry may be issued such as additional TLD dosimeters, or electronic dosimeters, etc.

4.5.3 Proper Use of Personnel Monitors

Whole body monitors can be worn on the belt or at chest level but if a leaded apron is worn, the monitor must be worn at the collar outside of the apron.

Extremity Monitors are usually worn on a finger with the detector on the palm side of the finger. Use

the following guidelines:

- Wear personnel monitors at all times when working with radiation.
- Store monitors away from sources of radiation when not in use.
- Avoid exposing the monitor to environmental extremes (e.g., moisture or heat).
- Exchange monitors promptly when the replacements arrive.
- Use only a monitor that is issued to you.

4.6 Bioassays

Individuals are monitored for internal exposure by means of bioassay, which is the analysis of the uptake of radioactive materials in the body by direct counting of the body or body parts (*in vivo*), or by the analysis of excreta (*in vitro*). There are two types of routine bioassays that may be used at UCSC, thyroid counts for radioiodine and, infrequently, urine assays for tritium.

4.6.1 Federal and State Regulatory Requirements

Federal and state regulations require individual monitoring for any person who has the potential for intake of radioactive materials under such conditions that they are likely to receive internal doses exceeding ten percent of any of the applicable regulatory limits.

There are few, if any, individuals at UCSC who are required to have bioassays under the provisions of NRC and/or DHS regulations. However, for campus administrative purposes:

- The UCSC radioactive materials license requires bioassays for individuals using 1 mCi or greater of radioiodine and/or greater than 100mCi of tritium.
- The RSO may require bioassays at lower levels of use at their discretion.

4.6.2 Participation

All workers handling radioactive iodine in amounts exceeding 1 mCi or at the discretion of the RSO shall be monitored. All workers handling 100 mCi of tritium or more or at the discretion of the RSO shall be monitored.

Specific procedures and requirements for bioassay can be obtained from EH&S Radiation Safety.

4.7 ALARA Review of Exposures

All exposure results will be reviewed by EH&S Radiation Safety. Exposures ≥ 100 mrem on a whole-body badge, or 500 mrem on an extremity badge, will be investigated by EH&S Radiation Safety to determine the cause and to identify how future exposures can be reduced.

4.7.1 Routine ALARA Exposure Investigations

Combined external and internal radiation exposures are routinely investigated by EH&S Radiation Safety to determine the conditions of exposure and to suggest preventive measures to maintain future exposures ALARA if they reach the applicable UCSC Administrative Guideline during the year.

A lower monthly exposure may be investigated for any reason at the discretion of the RSO.

4.7.2 Special ALARA Exposure Investigations

The RSO will conduct a special ALARA exposure investigation, which will be reviewed by the RSC, when any individual's combined external and internal exposures reach the applicable UCSC Administrative Guideline during the year.

4.7.3 Investigation of Overexposures

EH&S Radiation Safety is responsible for notification of DHS in cases of known or suspected exposure above the regulatory dose equivalent limits.

Medical evaluation and/or treatment by a qualified physician for any overexposed personnel may be required by the RSO, the RSC, or the appropriate regulatory agency.

4.8 Documentation of Decision Not to Badge

The RSO shall evaluate potential exposures to radiation as part of their review of all RUAs and amendment requests and determine if dosimetry is required or desirable to be issued.

4.9 Distribution of Monitoring Results and Notifications

Exposures measured by personnel monitors and determined from bioassays are reviewed by the RSO. An annual summary of individual exposure will be distributed to every person receiving dosimetry. The worker can request in writing a summary report of exposures received while working at UCSC at any time.

5 REGISTRATION AND TRAINING OF PERSONNEL

All Radiation Users (RH, RU, Rotation Students, Classroom Students, EH&S Staff) engaged in the use of radioactive materials, radiation producing machines, or entering restricted areas are under the supervision of an RH. Radiation Users must be registered with EH&S Radiation Safety and be specifically named on at least one RUA (Rotation Students are listed on a special RUA) or listed on a class roster. Each proposed Radiation User shall submit a *Statement of Training and Experience* to the RSO for approval.
Approved personnel are designated as Radiation Users and recorded as designated on each RUA or class roster.

Radiation Users who are occupationally exposed must be informed of the hazards that they may encounter and of methods available to protect themselves, as well as other matters as stated in 17 CCR (10 CFR 19).

To satisfy the training requirements, the RSC requires that:

- All of those working with ionizing radiation are trained to work with radioactive materials or radiation producing machines safely prior to the start of work.
- RUs complete refresher training annually and retain proficiency with regard to radiation safety requirements.
- EH&S Radiation Safety provides general and, upon request, specialized training to meet most training requirements. When necessary, additional training from outside sources may be recommended.

5.1 Training in Radiation Safety

The RSC shall approve the radiation safety training materials used to meet the training requirements. The training program shall include initial training for new users and annual retraining. Training sessions shall be offered online or as needed in-person. All Radiation Users are required to meet these training requirements.

Class users may be trained in radiation safety by the instructor using a syllabus approved by the RSO or by completing the normal radiation safety training offered online. It is the RH's responsibility to ensure that each Radiation User under his/her direction is properly trained specifically to the operations they plan to do and in compliance with the campus radiation safety training requirements.

5.2 RH's Safety Training Responsibilities

The RH shall be responsible for informing and instructing all individuals working in or frequenting any portion of a controlled area. Informing and instructing ancillary workers is included. They shall be:

- Kept informed of the storage, transfer or use of radioactive materials or radiation level in any portion of a controlled area.
- Instructed in certain aspects of safety training as specified by the RSO or as described in the RUA conditions.
- Instructed to observe the applicable provisions of the manual for the protection of personnel from unnecessary exposure to radiation or radioactive materials.

- Instructed to report promptly to the RSO any condition that may lead to or cause a violation of the Radiation Safety Manual's requirements for preventing excessive exposure to radiation or to radioactive materials.
- Instructed in the appropriate responses to warnings made in the event of any unusual occurrence or machine malfunction that may result in excessive exposure to radiation or to radioactive material.
- Instructed in their rights and responsibilities as Radiation Users.
- Expected to know where to find the Radiation Safety Manual and related EH&S Radiation Safety documents relevant to their work, to know of the location of posted radiation safety documents (physical or virtual) and emergency instructions in the laboratory, and to read all required postings.

5.3 Initial RH Training

The RH typically has a background in radiation work and this background is provided on their Statement of Experience form. The RH must complete initial radiation safety training. Initial RH training includes a briefing on the unique aspects of the UCSC radiation safety program. A new RH is required to read the Radiation Safety Manual.

6 STANDARD OPERATING PROCEDURES

Every person who uses radioactive materials or radiation producing equipment is responsible for handling materials to ensure that personnel radiation exposures are ALARA. This section includes standard laboratory procedures and requirements to accomplish this goal. The RUA will prescribe additional specific precautions and conditions.

6.1 Procurement Procedures

Prior approval is required for the procurement of all radioactive materials and radiation producing equipment whether procurement is by a purchase, transfer, loan, or gift. The criteria for approval are based on the RH possessing a valid RUA. Only isotopes listed on the RUA may be purchased. The total inventory (including the current stock in the lab, radioactive waste in the lab, and the new purchase) must not exceed the limit in micro Curies on the RUA for each isotope ordered.

6.1.1 Submission of Requisitions

Requisitions for radionuclides or radiation producing machines are submitted to the Procurement Department through CruzBuy. Only Radiation Users may purchase radioactive materials. See Appendix for specific instructions for CruzBuy.

6.1.2 Approval of Requisition

When a requisition is requested in CruzBuy, the RSO or designated Radiation Safety professional will approve the order and Procurement will order the product.

6.1.3 Approval and Recording of Transfers

Before any transfer of radioactive materials between RHs, written or verbal approval from the RSO or his/her delegate must be obtained. Both the transferor and recipient must record the applicable changes in their radioactive materials inventory.

Off-campus transfers are governed by federal and state regulations; therefore, all arrangements for such transfers shall be made by EH&S Radiation Safety.

6.2 Receipt of Radioactive Material

All radionuclide shipments are delivered by the carrier to the Thimann Laboratories Building receiving office for pickup and inspection by EH&S Radiation Safety. Radiation Safety inspects all packages with respect to the following:

- Conformity of radionuclides with the approved requisition specifications.
- Damage or contamination of the contents or shipping containers.
- Conformity with D.O.T. regulations.

If the radionuclide shipment passes inspection, it is delivered to the RH's laboratory and the amount of material received is added to EH&S Radiation Safety records of radioisotope receipts. Approval must be obtained in advance for special handling of shipments that do not follow the procedures described above.

6.3 Security of Radioactive Material

The RH shall be continuously responsible for the custody of any radioactive material or radiation producing machines acquired under the RUA.

Any loss of radioactive material must be reported to EH&S Radiation Safety immediately by calling campus dispatch at 911 and asking for EH&S Radiation Safety assistance.

6.3.1 Restricted Area

A Restricted Area is one of high security into which access is restricted to authorized personnel in order to prevent undue risk from exposure to radiation or radioactive materials. All entrances to restricted areas shall remain closed and locked when not under constant surveillance by authorized personnel. Laboratory space for a Class 3 RUA may be considered a "Restricted Area."

Members of the public are not allowed in Restricted Areas without the escort of the RH or EH&S Radiation Safety staff.

6.3.2 Controlled Area

A Controlled Area is a limited access area such as any laboratory that uses radioactive materials or possesses an RPM. Requirements for a controlled area include:

- Restricting access (i.e., door locks or locked storage) to the area when it is not occupied by authorized personnel.
- Identifying, with signs, the area(s) exposed by radiation and/or the area where radiation sources are used or stored.
- Licensed radioactive materials stored or used in controlled areas shall remain either under the surveillance of authorized personnel or else secured from unauthorized removal or access.

6.4 Controlled "Radiation Use" Areas

Where radioactive materials are stored in normal radionuclide use laboratories at the Class 1 and 2 level, the area shall be treated as a "controlled area."

6.5 Inventory Control and Possession Limit

Each RH shall keep records of physical inventories of all radioactive materials under their control. This inventory shall be by radioisotope, millicurie amount, activity date and storage location. For unsealed sources, the inventory records should also include sufficient additional information to facilitate locating the materials such as: how much activity is stored in the original container; how much has been transferred to another container (in solution, for example); how much is stored in tissue; how much is in liquid or solid waste, etc. Each lab should designate a member to be responsible for periodically visually verifying the locations of all materials inventoried. The RH is responsible for ensuring that the records are kept current and accurate.

Care must be taken to ensure that the RH does not exceed the possession limit(s) (by radioisotope and chemical form) specified in the authorization by meeting the following requirements:

- Each order must be within the specified limits listed on the RUA.
- A Quarterly Inventory is verified in-person by EH&S Radiation Safety.

Although each order is checked by EH&S Radiation Safety, the user must be aware of their possession limit, so as not to place multiple orders that would exceed it.

6.6 Posting Requirements for Radiation Laboratories

Approved radiation warning signs of the approved type are required where the potential for exposure to radiation exists.

All laboratory areas must post:

- The "Notice to Employees" Form (RH2364) sign. This is a form that outlines specific rights to fair and safe treatment for Radiation Users and must be posted at appropriate locations as required by 17 CCR §30255.
- Emergency laboratory procedures and phone numbers.

Current standard operating procedures and the RUA will be in the Radiation Safety binder and/or stored online.

6.6.1 Caution Radioactive Material

Laboratories that store or use radionuclides shall be posted at all entrances with a sign bearing the radiation caution symbol and the words "CAUTION RADIOACTIVE MATERIAL."

6.6.2 Caution Radiation Area

Laboratories that store or use radionuclides with doses that may exceed 5 mR/h shall be posted at all entrances with a sign bearing the radiation caution symbol and the words "Caution Radiation Area."

Labeling Requirements

6.6.3 Containers

All containers and sealed sources of radioactive materials, except those containing counting samples (planchets and vials), must bear a label with the following information:

- Radiation trefoil with text "Caution: Radioactive Material"
- Radioisotope
- Quantity
- Date

Where double containers are used, both inner and outer containers require labeling unless the inner label is visible from outside. Proper labeling requirements also apply to radioactive waste.

6.6.4 Equipment

Equipment that is used with radioactive materials must be labeled with a radiation trefoil and text "Caution Radioactive Material.".

6.6.5 Work Areas

All work areas, including tabletops and equipment, used in radionuclide procedures must be labeled. A good method is to cover workbenches with absorbent paper and use "Radioactive Material" labeling tape to secure the edges. Storage areas such as refrigerators also must be properly labeled.

6.6.6 Sealed Sources

The source, its shield, or the apparatus in which the source is mounted must bear a permanent radiation warning sign. Even though such sources are fully and effectively controlled, all persons associated with their operations must be informed regarding both operational and emergency precautions.

6.7 Radiation Exposure and Contamination Control in the Laboratory

The following guidance is given to limit radiation exposure and to control contamination.

6.7.1 Internal Exposure

Risks that can result from internally deposited radionuclides are a matter of personal and public concern. Internal uptake is best avoided by implementing containment techniques, minimizing surface contamination, using appropriate personal protective equipment, and using proper engineering controls.

The following precautions are to be taken when working with unsealed radioactive materials to prevent the intake of these materials into the body:

- Food and beverages are not permitted and may not be consumed in areas where unsealed radioactive materials are stored or used. Any food or beverage containers found in radioactive workplaces during RSO inspections will be confiscated until they are determined not to be contaminated. Any foodstuffs will be discarded.
- Smoking is not permitted in workplaces where radioactive materials are used. All smoking material found in radioactive work areas will be discarded.
- Applying cosmetics while in radiation workplaces is prohibited.
- All pipetting of radioactive materials shall be done by mechanical methods. Mouth pipetting is prohibited.
- A fume hood shall be used for handling any radioactive material that may become airborne.

6.7.2 Shielding and Exposure Control Requirements

Requirements for shielding and/or remote handling devices will depend upon the external radiation levels of the specific radioisotopes and amounts to be handled. Specific requirements will be established by the RSO or RSC.

In Controlled Areas:

Experimental setups and storage operations should be designed so that the dose rate in laboratories measured at 30 centimeters from any unshielded source or shielded enclosure is minimized. Suggested maximum dose rates is:

- 2 millirems per hour shallow dose equivalent rate.
- When dose rates in controlled areas are expected to routinely be above the design guidelines, remote area monitors, with alarm, will be installed to measure gamma and/or neutron dose rates, as appropriate.

In Unrestricted Areas:

- Deep, lens and shallow dose equivalent rates at 5 centimeters from the boundaries of any adjacent controlled area should be below 2 millirems in any one hour.
- In addition, the total effective dose equivalent (TEDE) to any member of the public should be below 100 millirems in any year.

6.8 Radiation Control Techniques

The following are general procedures for radiation control in a radioisotope laboratory. Although the special requirements for each laboratory make it challenging to establish rules for all situations, the following practices, with slight modifications, satisfy most needs.

- Separate radiation work and storage areas from general personnel spaces.
- Store personal belongings, other than those required for work outside of the laboratory.
- Prohibit eating, drinking, smoking, and application of cosmetics in the laboratory.
- Cover all work areas with absorbent paper to protect against spillage.
- Provide necessary and appropriate shielding.
- Place waste materials in containers as specified in this manual.
- Maintain good housekeeping throughout the laboratory.
- Restrict public access.
- Use appropriate signs.
- Wear impervious gloves.
- Do not work when open skin wounds can be contaminated.
- Wear proper PPE including laboratory coat, protective eyewear, gloves and sturdy close-toed shoes.
- Clearly label all contaminated glassware or equipment until it has been decontaminated.
- Restrict work with volatile materials to special fume hoods, and work with radioactive powders in glove boxes.
- Keep away all radioactive materials, other than counting samples, from counting areas.
- Label work areas, materials, and/or containers as required by regulations, or as a condition of the specific approval.
- Survey radiation use areas with an appropriate survey technique, i.e. survey meter or wipe test and document survey results at least monthly or as specified on the RUA.
- Where appropriate, use radiation detection equipment during manipulations of unsealed radionuclides to detect and prevent the spread of contamination. Periodically check gloves and forearms for contamination.
- If, in the course of work, contamination is suspected, monitor the area with a suitable survey meter or by "area wipe" test and decontaminate if necessary.
- Before leaving the laboratory, wash hands and check with a suitable survey meter.

6.8.1 Additional Requirements for High and Very High Radiotoxicity Nuclides

- Preplan the operation in detail.
- Provide shielding as required.
- Decide actions required in case of emergencies.
- Develop the personal skills necessary to satisfy the special needs of the project.
- Inform personnel working with radioactive materials (and those who could be affected by incidental exposure or accidents) of safety practices and emergency procedures.
- Personnel monitors are to be worn by all persons participating in a project as they are specified in the RUA approval.
- Use appropriate laboratory facilities and equipment.
- Restrict procedures to one radioisotope and one operation at a time wherever possible. Avoid simultaneous and conflicting hazardous situations.
- Monitor all areas and operations routinely.

6.9 Laboratory Surveys

While the majority of UCSC programs for radiation control rely on correct experimental design, the problem of contamination is most easily handled when appropriate contamination monitoring surveys are performed routinely by the Radiation User. Routine laboratory surveys are required in research and teaching laboratories to detect excessive radiation and/or contamination levels in order to alert laboratory personnel to potential hazards.

All user surveys are required to be performed at ***least monthly*** unless otherwise specified on the RUA. If no use has occurred, no monitoring is required, but the period of no use needs to be documented.

The RSC requires all users of radiation to equip themselves with instruments capable of assessing ambient radiation levels and/or radioactive contamination levels of the radioisotopes to be used. Recommended surface contamination instruments are listed in Table 10.

Table 10
Recommended Contamination Detection Instruments

Radiation Type	Energy	Isotope Example	Detector
Alpha	All	Am-241	ZnS scintillation Proportional Wipe test – LSC
Beta	< 200 KeV	H-3, C-14, S-35	Wipe test – LSC
	≥ 200 KeV	P-33, P-32	Pancake GM Proportional Wipe test – LSC or sample holder
Gamma	> 20 KeV	Cr-51, I-125	Thin NaI scintillation Wipe test – gamma well Wipe test - LSC
	≥ 20 KeV	Na-22, I-131	Thick NaI scintillation Wipe test – gamma well Wipe test - LSC

Survey Records

Permanent records must be kept of all survey results, **including negative results**. The records will include:

- Location, date, and type of equipment used.
- Name of person conducting the survey.
- Schematic of area surveyed, identifying relevant features such as active storage areas, active waste areas, etc.
- Measured exposure rates and/or contamination levels keyed to location on the drawing.
- Corrective action taken in case of contamination or excessive exposure rates, and the reduced contamination levels or exposure rates after corrective action.
- Wipe tests used for state and federal compliance must be calculated or recorded in disintegrations per minute, (dpm).

6.10 Decontamination Requirements

During the course of work laboratory surfaces, equipment, clothing, etc., may become contaminated in spite of precautions. Such contamination does not necessarily present a serious hazard, provided it is detected promptly and not allowed to spread or be ingested.

It is the responsibility of the RH to see that decontamination is carried out properly and to instruct personnel in decontamination procedures. EH&S Radiation Safety will aid or provide supervision in cases of gross or personal contamination that the laboratory cannot handle themselves.

During a decontamination procedure, it is important to:

- Wear appropriate protective clothing (gloves, lab coat, and safety glasses).
- Confine the spread of contamination (start from areas of low contamination and work towards higher contaminated areas).
- Carefully remove all loose or easily removable contamination to the appropriate radioactive waste container, followed by washing the contaminated surface with soap, or detergent.
- Place all cleaning materials (absorbent materials, gloves, etc.) in a radioactive waste container.

Glassware and other contaminated equipment should be cleaned using laboratory detergents, or cleaning solutions as appropriate. All equipment contaminated with long-lived radionuclides that cannot be cleaned to acceptable levels must be discarded as radioactive waste. Such glassware and equipment should be destroyed to prevent accidental return to stock or other use. Equipment contaminated with short-lived radionuclides and stored to allow for radioactive decay must be clearly identified and stored in a secure location.

Workplace surfaces and floors that cannot be decontaminated to acceptable levels must be a) treated to fix the radioactivity in place and shielded to bring exposure limits to an acceptable level, b) identified as a radiation area, or c) isolated to allow for radioactive decay, or removed and disposed of as radioactive waste.

6.10.1 Tolerable Decontamination Levels

Radioactive contamination on skin, clothing, radioactive work surfaces, equipment and facilities should be kept ALARA, and must not exceed the levels specified in Table 11. Compliance with these levels can be determined by the use of an appropriate survey meter or area wipe.

Table 11
UCSC Contamination Limits[10]

TYPE OF SURFACE	Total Includes Removable and Fixed Contamination dpm/100 cm²	Removable Contamination		
		α Emitters dpm/cm²	β, γ or X Emitters Radiotoxicity Level 3, 4, and 5 dpm/cm²	β, γ or X Emitters Radiotoxicity Level 1 and 2 dpm/cm²
Restricted and Controlled Areas				
Within posted radioactive materials zones	1,000 α 10,000 β, γ or X	200	2,000	10,000
Outside posted radioactive materials zones	100 α 1,000 β, γ or X	20	200	1,000
Skin, personal clothing and protective clothing	Below detectable limits			
Unrestricted Areas				
All surfaces, including items removed from restricted and controlled areas	Below detectable limits			

6.11 Radioactive Waste Management

The Radioactive Waste Management Program is designed to protect the individuals dealing with waste and the environment. All radioactive waste must be transferred to EH&S Radiation Safety for disposal. No radioactive materials are permitted to be discharged into the sanitary sewer, released into the air, or disposed of in the regular trash.

Mixed wastes should be separate from other radioactive waste. Mixed waste is defined as chemically hazardous waste and as radioactive. Lead is an example of a chemically toxic waste, so lead pigs should not be combined with the other solid waste. If the waste contains any known hazardous constituent, those hazards must be identified both on the waste container.

Isotopes should not be mixed in single containers, because each isotope has a different half-life. Under the University's license, radioactive waste materials with half-lives shorter than 120 days can be safely disposed of after the passage of 10 half-lives, and a verification of a background dose rate; all other waste must be packaged for disposal by an outside contractor.

[10] Adapted from Table 2 from Reg. Guide 8.23, Jan '81.

According to the UCSC Broad Scope Radioactive License, Ca-45 must be held for 15 half-lives before disposal in the regular trash.

EH&S Radiation Safety makes routine waste pickups. To arrange an additional pickup, email the Radiation Safety Specialist at rad@ucsc.edu.

6.11.1 General Considerations

When disposing of radioactive waste, recognize that other hazards can be present (e.g., biohazards, chemicals, sharps, etc.) and that each must be treated appropriately.

Personnel exposure and/or area contamination shall be avoided by shielding waste containers and minimizing the quantity of waste stored in labs.

Radioactive waste must NOT be placed in any ordinary trash receptacle.

Reduce waste volume whenever possible. After monitoring, discard any uncontaminated material (e.g., packing material) in the ordinary trash or according to its other hazards.

Remove or completely deface all radioactive material labels from nonradioactive materials/packages when they are placed in the ordinary trash receptacle or the radioactive waste.

Do not mix other hazardous waste with radioactive waste (unless you have an approved SOP).

Eliminate hazards at the point of generation when legal (e.g., some biohazards can be eliminated by sterilization). Contact EH&S Radiation Safety for assistance (x92553).

Only use waste containers provided or approved by EH&S that are chemically compatible with the

6.11.2 Waste Labeling

Label all waste containers appropriately.

Before adding waste, attach a radioactive material label and, if appropriate, identify:

- RH's name
- Date the waste was first placed into the container.
- Isotope(s) present.
- Amount of activity of each isotope.
- Other hazardous materials present (e.g., organics, corrosives, toxics, etc.).

6.11.3 Solid Radioactive Waste

All solid radioactive waste must be placed in plastic-lined containers authorized by EH&S Radiation Safety. To protect personnel from injury, all hypodermic needles must be placed in a puncture-proof sharps container before being placed into the solid waste box for disposal. No liquids, animal remains, or active pathological agents are permitted in the solid waste containers. Deface all caution radioactive waste stickers prior to disposal.

6.11.4 Liquid Radioactive Waste

Collect all liquid radioactive wastes in EH&S Radiation Safety approved plastic carboys with tight screw caps. Fill containers only to 80% of capacity.

Maintain all liquids at a pH between 6-9. Keep liquids containing iodine at a slightly basic pH (pH 8-10) to reduce the volatilization of radioiodine.

Place aqueous and water-soluble materials in separate containers from non-aqueous materials to allow for varying disposal site requirements.

Place all liquid waste containers in secondary containers (e.g., plastic dish pans) of sufficient size to contain all of the liquid in the bottles in case of breakage or leakage.

Liquid P-32 is decayed for ten half-lives, sampled to assure background activity, and given to the Hazardous Waste Coordinator for disposal.

Because of stringent local restrictions, no liquid radioactive materials are permitted to be discharged into the campus sanitary sewer system.

No solid materials or active pathological agents are permitted in liquid waste containers.

6.11.5 Animal Waste

Place all radioactively contaminated animal carcasses, tissues, and excreta in sealed double plastic bags.

Keep carcasses containing 0.05 μCi/gram or less of C-14 or H-3 separate from all others and clearly labeled.

Store all animal waste frozen, either in your lab or in a specially designated departmental freezer.

6.11.6 Liquid Scintillation Cocktail (LSC) Vials

Package LSC vials separately from all other wastes, in EH&S-approved containers.

NO other material of any kind is to be included in the containers with LSC vials.

6.11.7 Other Wastes

In cases where radioactive material cannot be disposed of as outlined above, the EH&S Office should be consulted before the waste is generated. Special procedures may be required by the RSO and/or the RSC.

6.11.8 Segregation Scheme

In order to manage radioactive waste efficiently, segregate according to type at the point of generation as indicated below. All radioactive wastes are to be segregated according to their half-life. Specific instructions and Waste Disposal Tracking Forms are available from EH&S Radiation Safety.

1. Dry solid
   a) Short half-life ($T½ \leq 120$ days)
   b) Long half-life ($T½ > 120$ days)
2. Liquid
   a) Short half-life
      i. Aqueous based non-chemically hazardous
      ii. Mixed waste
   b) Long half-life
      i. Aqueous based non-chemically hazardous
      ii. Mixed waste
3. Liquid Scintillation Vials
   a) H3 and/or C14 liquid scintillation cocktails <0.05 μCi/ml.
   b) Other radionuclides

4. Biological[11] (animal carcasses/medical waste)
   a) Short half-life
   b) Long half-life
   c) H3 and/or C14 with <0.05 uCi/g or ml
5. Sharps (needles, broken glass, pipette tips)
   a) Short half-life
   b) Long half life
6. Stock vials (empty or full)
   a) Short half-life
   b) Long half-life
7. Sealed sources

The only exception(s) to the above segregation scheme should be mixtures that are produced as a result of a necessary procedure or process. If there are questions, call EH&S Radiation Safety.

6.11.9 Storage as a means of Disposal

Short lived radionuclides can be held for decay as a means of disposal outside of the research laboratory in a designated EH&S radioactive waste storage facility. The Radiation Safety staff shall determine which radioactive waste is routed into this program and facility.

[11] Shall be frozen if held for more than 24 hours before pickup by EH&S Radiation Safety.

7 REQUIRED RECORDS

7.1 EH&S Radiation Safety Maintained Records

The RSO is responsible for the maintenance and control of all central record keeping requirements including the registration of sources of hazardous radiation, RUAs under the program, inventory of radioactive materials, disposals of radioactive waste, inspection reports, monitoring records and other records required by the State of California, NRC, and other enforcing agencies.

Application and Authorization - Copies of the original application and authorization must be kept on file at EH&S Radiation Safety.

Changes in Authorization - The RH shall notify the RSO of any expected changes (i.e. possession, use, personnel or facilities) in authorized use. The RSO will then advise the user as to the proper procedures for obtaining approval of such changes.

Personnel Records – Copies of *Training and Experience Forms* for each DU. Copies of all training documents. Declarations of pregnancy.

EH&S Radiation Safety Audits –The RSO shall maintain records of audits conducted in compliance with this manual. Records shall be maintained for a period of at least three years.

Dosimetry - Individuals that require personnel dosimetry will receive a yearly monitoring report from EH&S Radiation Safety that lists the exposure from external sources and internally deposited radioisotopes, as appropriate. EH&S Radiation Safety shall maintain dosimetry records.

Bioassay - The Radiation Safety Office shall maintain records of all bioassays conducted in compliance with Appendix V of this manual.

Leak Testing -The RSO shall maintain records of the results of leak tests of sealed sources.

Spills and Contamination – EH&S Radiation Safety shall be notified immediately of any major spills and/or gross contamination of facilities.

Training Records - EH&S Radiation Safety will maintain copies of Training and Experience Forms.

7.2 RH Maintained Records

Each RH must maintain records in a laboratory binder (e.g., 3-ring binder titled *Radiation Safety Laboratory Records*) or in an online format approved by the RSO. The journal is a necessary part of the records required by state regulations, and shall be kept in the laboratory available for review by EH&S Radiation Safety and state inspectors at all times. Records must contain the following information:

- A copy of the approved RUA and any amendments to that application. The RUA will list any specific requirements or conditions of use.
- A copy of this Radiation *Safety Manual* that is available to all Radiation Users. Access to the on-line version is also acceptable.
- Copies of the Radioactive *Material Receipt and Use Log* indicating the receipt of each radioisotope (isotope, chemical, and/or physical form, quantity and date of receipt), including any radioactive materials transferred from one RH to another. The logs should record the date, activity, and use of each withdrawal from stock.
- Records of disposal of isotopes and contaminated lab material that indicate the date, activity, physical form, and method of disposal.

- Records of laboratory contamination self-surveys. Entries must include the date, person making the survey, the instrument or method used, location and levels of activity encountered. When required, a statement regarding the average exposure reading encountered in work areas should be included, even when this value is essentially background. When the cause of high readings is known, it should be identified.
- A complete history of and corrective action taken for any accident which involves a "major" spill.
- Data necessary to demonstrate compliance with any special requirements placed on the specific authorization.

8 RADIATION PRODUCING MACHINES

Campus radiation machines are divided into five categories, based upon the hazards involved, and the prevalence of the machines on campus. The five categories are:

1. Electron Microscopes
2. Medical Machines
3. Cabinet X-ray Machines
4. X-ray Diffraction and Fluorescence Analysis Machines
5. Miscellaneous Machines

General Regulations apply to all radiation machines, while Specific Regulations apply only to certain categories.

8.1 General Regulations

8.1.1 Possession

No radiation machines shall be brought onto campus without prior notification of the RSO. Approval to operate shall be obtained from the RSC and the RSO. This approval shall consider possible effects on others and their work, need for special shielding, and any other pertinent items. Approval is required regardless of the means of acquisition (e.g. purchase, lease, gift, loan, "in-house" fabrication) and regardless of ownership.

No radiation machines shall be removed from campus or deactivated without approval of the RSO. Any machine de-activated but left on campus must be marked "De-activated radiation machine. Do not move or re-activate without prior approval of the RSO."

The Radiation Safety Officer shall notify the State of California Department of Health Services within thirty days of receipt, transfer or disposal of any radiation machine. The Radiation Safety Officer shall renew registration of all campus radiation machines as required.

8.1.2 Use

No radiation machine shall be used except in strict compliance with a valid RUA. The RUA shall list the RH, describe the machine, and specify (directly or by reference) the specific machine operators, operating parameters, procedures, locations, dosimetry, and the safety precautions that shall be used.

The RSO shall be notified of changes in personnel or machine location, and of machine repair. Prior approval by the RSO shall be obtained for machine modifications.

Safety interlocks shall never be used to deliberately terminate machine operation except for test purposes.

8.1.3 Personnel

Each radiation machine shall be controlled by an RH who is responsible for ensuring compliance by all operators with all applicable regulations. The RSC and the RSO shall approve each RH. Approval requires adequate knowledge, and academic or staff stature sufficient to permit the RH to obtain compliance by all operators.

Use of each machine shall be by or under direct supervision of an approved operator listed on the RUA and is contingent upon the person demonstrating adequate knowledge and ability for safe use of the machine. An authorized repair person may operate a machine during setup, testing, and repair if prior permission from the RSO is obtained for each such use.

8.1.4 Radiation Exposures

Radiation-producing machines shall be used according to the instructions of the manufacturer such that:

- The radiation exposure to operators and other individuals in the surrounding areas is as low as reasonably achievable.
- The machine does not exceed the exposure limits specified in Part 4 of this manual.
- Dosimetry Program:

Dosimetry is not needed for x-ray diffraction, x-ray fluorescence, or electron microscopy laboratories due to the insignificant estimated dose. This determination is based on survey data collected outside of the machine when it is operating under normal conditions.

Dosimetry is currently required for X-ray Users in the Student Health Center. Whole body monitors are to be worn at the neck or torso. All issued badges should be exchanged on the proper frequency.

If a student or employee is being monitored with dosimetry at UCSC and they plan to work at an outside institution such as a national lab, university, or hospital where they might receive a dose from ionizing radiation the employee should be evaluated by the outside institution for dosimetry needs. UCSC badges are to be worn only at UCSC and not to be worn at another institution. If a badge is given from the outside institution and there is a dose above zero or non-detectable, a copy of the annual dose report is required to be sent to the UCSC RSO to add to any potential UCSC doses the individual may have received for the year. If the annual dose is zero or non-detectable from an outside institution, the annual report is requested to be sent to the UCSC RSO.

If you lose a dosimeter, please report the loss to the RSO immediately. Do not work with X-ray producing equipment in the Student Health Center until you have filed a lost dosimeter report and received a replacement dosimeter. When notifying the RSO of a lost dosimeter, indicate how and when the dosimeter was lost, what will be done to prevent recurrence and any activities that you performed, which may have resulted in an exposure to radiation. Please recognize that lost dosimeters incur additional charges from the vendor.

ALARA program

a. An ALARA level 1 dose is a badge reading that is 10% of the quarterly annual dose. For a whole-body dosimeter 10% of the quarterly dose is 125 mrem. The X-ray User will be notified of the ALARA level 1 dose. This is not a hazardous dose, but an investigation of how the dose was received and how it can be reduced will be conducted by the RSO. Recommendations will be given to the X-ray User and reported to the RSC and the XUA Holder.

b. An ALARA level 2 dose is 20% of the quarterly dose. For a whole-body dosimeter this is 250 mrem. The X-ray User will be notified of the ALARA level 2 dose. This is not a hazardous dose, but it would be highly unusual for a UCSC employee, staff, or student to get such a high dose. The RSO will conduct a dose investigation, and the X-ray User's privilege to use x-rays will be suspended until the investigation is complete and reviewed by the RSC. Recommendations to reduce future doses will be provided by the RSO and RSC to the X-ray User and the XUA Holder.

EMERGENCY REPORTING

If one believes a patient or employee was exposed to more than the normal dose of x-rays in the Student Health Center, or if an interlock malfunctions and one believes that their extremities were exposed to x-ray diffraction or x-ray fluorescence:

a. Call 911 to seek medical attention and notify EH&S immediately.
b. Follow-up with reporting to your supervisor and EH&S at: https://ehs.ucsc.edu/. Click on the yellow tab of the appropriate situation, such as Hazard Concern, Serious Injury, Laboratory Incident, or Near Miss.

8.1.5 Personal Protective Equipment

In general, personal protective equipment (e.g., leaded aprons, gloves, and/or goggles) are useful only for low energy (less than about 100 kVp) X-ray sources. Recognizing this limitation, personal protective equipment should be used to protect any part of the body that may be exposed by a primary X-ray beam or wherever their exposure can be reduced significantly by their use, but not in place of other required engineering controls.

8.1.6 Machine Location

As a general safety precaution, and to provide security during unattended operation, it may be desirable to dedicate an entire room or area that can be secured to a radiation-producing machine. When this is not possible or desirable, the machine should be placed in an area out of the main traffic flow and away from high-occupancy areas. Unless confined or limited by other means, primary beams shall be intercepted by a primary barrier and limited such that they cannot irradiate personnel. Scatter and secondary radiation shall be controlled such that the radiation exposure is as low as reasonably achievable, but in no case greater than the limits specified in this manual. With the exception of mobile X-ray and dental units, any change in location of a radiation producing machine must be approved by EH&S Radiation Safety.

8.1.7 Posting and Labeling

All radiation machines shall be clearly and visibly labeled to caution individuals that such machines produce radiation when operated.

Radiation Areas as defined in section 6.6.2 of this manual shall be posted as required.

A copy of the Campus Radiation Producing Machine Safety Procedures shall be posted in the immediate vicinity of each machine.

8.1.8 Radiation Surveys

The RSO shall survey each machine before routine use, following any major changes in configuration or repairs, and at least on an annual basis.

The RH or approved operator(s) shall survey the machine for radiation leakage as specified by the RUA.

8.1.9 Facility Review and Inspections

Plans for facilities that include radiation producing machines must be reviewed before they are put into operation and periodically thereafter to ensure that they are and remain safe and in compliance with appropriate federal, state, and local regulations.

Initial Review: EH&S Radiation Safety shall inspect any new or modified radiation producing machine or facility before its operation. The inspection is intended to determine if the facility/radiation-producing

machine is safe for the intended use and that it complies with appropriate federal, state, and local regulations.

Periodic Inspections: Yearly, EH&S Radiation Safety shall inspect facilities that include radiation producing machines to ensure that they are in safe operating condition and in compliance with appropriate federal, state, and local regulations/requirements.

8.1.10 Radiation Monitoring Dosimetry

Individually assigned dosimeters or badges supplied by the Office of EH&S shall be used when so specified by the RUA.

All individuals working in areas where the potential for exposure to radiation meets the criteria specified in the UCSC Radiation Safety Manual shall wear radiation monitors. Typically, any individual working with any radiation producing machine should wear personnel monitors. Exceptions include standard electron microscopes, X-ray fluorescence units, and other self-contained low kV/mA machines. Required radiation monitors are available from EH&S Radiation Safety.

8.1.11 Safety Devices

Federal, state and local regulations for each radiation-producing machine require certain safety devices. Required safety devices include fail safe warning light, fail safe interlocks, beam enclosures, shielding, and radiation survey meters.

All safety devices shall be maintained in working order, and shall not be replaced or modified without specific approval by EH&S Radiation Safety. No safety device is absolutely fail safe or foolproof and should act only as a back-up, not as a replacement for proper procedures.

Safety devices must never be purposely defeated. If the design of a safety device makes a desired/necessary operation inconvenient or impossible, an alternate safety device/method shall be developed that provides the same degree of protection. Modified safety devices/methods shall be approved by EH&S Radiation Safety before operation of the radiation-producing machine. When safety devices are modified, it may be necessary to modify existing operating procedures and to retrain operators. If a required safety device fails, the machine shall not be operated until it is repaired, and subsequently checked, by EH&S Radiation Safety. EH&S Radiation Safety shall be notified immediately if an unexpected personnel radiation exposure occurs or is suspected.

No radiation producing machine shall be operated at any time unless all specified shielding and other safety devices are in place and functioning properly except when operated by an authorized repairperson.

8.1.12 Operating Procedures

Operating procedures approved by EH&S Radiation Safety must be available in the work area to all users of radiation producing machines.

8.1.13 Use Log

The purpose of a "Use Log" is to document the users, uses, and operating status of a machine. Information contained in this log can be useful when investigating incidents and/or determining the operating status/reliability of a machine. A "Use Log" shall be maintained for all radiation producing machines.

A "Use Log" shall include the following information for each time the machine is used: date of use, name of the operator, description of use, beam voltage, beam current, time beam turned on, time beam turned off, comments concerning operation abnormalities, repairs, etc.

8.2 Specific Regulations

8.2.1 Electron Microscopes

Operators shall maintain an operating log as described in 8.1.13.

8.2.2 Medical Machines

Operators shall maintain an operating log as described in 8.1.13.

All machine operations, installation designs, etc., shall be in accordance with published State of California Department of Health Services regulations and recommendations of NCRP reports 33, 35, 49 and their successors, for human use.

8.2.3 Cabinet X-Ray Machines and Fluorescence Analysis Machines

Log: Operators shall maintain an operating log as mentioned in 8.1.13.

Enclosure: Machines shall be used only in shielded boxes or rooms such that no radiation levels outside the shield exceed 2 mrem per hour, no person is within the shield at any time while the machine is producing X-rays, and all shield entrances are interlocked in some manner so that any attempt to enter will shut off the machine.

X-Ray Indicators:

- Each machine shall be provided with a conspicuous fail-safe warning light or device that indicates whether the X-ray tube is energized. The device shall be placed near the X-ray tube assembly and shall be labeled "X-ray on."
- There shall be a warning light or device labeled "X-ray on" near the switch that energizes the X-ray tube. This light or device should be of fail-safe design.

Safety Device Approval: The function of all interlocks, indicators, and other safety devices shall be checked and approved by the RSO prior to use.

8.2.4 X-Ray Diffraction

Log: Operators shall maintain an operating log as mentioned in 8.1.13.

Procedures: Normal operating and alignment procedures shall be documented and readily available.

Beam Stop: Each port shall have a beam stop in place that limits the dose rate immediately behind it to less than 2 mR/h at maximum settings.

Unused Ports: Unused ports shall be secured in such a way that tools are required to open them.

X-Ray Indicators: There shall be a conspicuous fail-safe light or device near the X-ray tube assembly that indicates whether the tube is energized. It shall be labeled "X-ray on."

There shall be a light or device near the switch that energizes the X-ray tube that indicates whether the tube is energized. It shall be labeled "X-ray on" and should be of fail-safe design.

Lock: Each machine should have a key-operated power switch. The lock should be constructed so that the key cannot be removed during operation. The key shall not be left in the lock when the machine is not in operation.

Beam Enclosure: During routine operation, the primary beam path shall be enclosed in a chamber that cannot be entered by any part of the body. The enclosure should be interlocked with the tube high voltage or shutter so that the beam cannot be available unless the enclosure is in place.

Shutter Interlock: Each port should be provided with a beam shutter that is interlocked with the accessory apparatus coupling or collimator in such a way that the port will be open only if the coupling or collimator is in place. Such a device shall be provided if there is to be any operation without an interlocked beam enclosure.

Shutter-Open Indicator: Each port should be provided with a shutter-open indicator of fail-safe design. Such indicators shall be provided if there is to be any operation without an interlocked beam enclosure.

Radiation Levels: The radiation level outside a beam enclosure shall not exceed 0.2 millirem per hour.

Survey Instrument: An appropriate operable radiation survey instrument shall be easily accessible at all times to each machine while in use. This instrument shall be used to monitor each initial setup and each significant modification thereof for excessive leakage, unsuspected beams, and other hazardous radiation conditions.

Safety Device Approval: The function of all interlocks, indicators, and other safety devices shall be checked and approved by the RSO prior to use.

Location: Each machine shall be located so that personnel in the general area shall not be subjected to unnecessary radiation exposure.

8.2.5 Miscellaneous Machines

All other machines not fitting in the above categories shall be classified as miscellaneous machines. Some examples would be particle accelerators, demonstration Crookes' tubes, high voltage supplies, etc.

All specific regulations for such machines shall be listed on the RUA for the machine.

The specific regulations for miscellaneous machines shall be similar in nature to those required for the other four machine categories.

9 EMERGENCY PLANS

When a radiation emergency is accompanied by other hazards (fire, explosion, chemical exposure, or other event that endangers life and/or property), it is important to deal first with those hazards that have the greatest potential impact. In an educational setting, the quantities and types of radiation used are such that, in general, response personnel (fire and medical) can deal with severe threats to life, health, and/or property without concern for the radiation present if 1) they respond with their usual personal protective equipment, and 2) are monitored for radiation contamination and decontaminated as necessary before leaving the site of the emergency.

Any spill or release of radioactive material must be controlled promptly. The responsibility for cleaning spills, or calling for experienced help, rests on the individuals working in the area involved and the Radiation User. Instructions for decontamination of minor spills and safe levels of contamination are specified in the Emergency Procedures for Spills of Radioactive Materials on page 2.

Under no circumstances should a laboratory person attempt to examine or clean up a *major* spill of radioactive material. A major spill is defined as an uncontrolled or inadvertent release of radioactive material that requires reporting to the California Department of Public Health. The cleanup techniques should be planned with the same care as is used in quantitative chemical analyses or in bacteriological handling of virulent organisms. Proper precautions taken immediately will protect human life, prevent environmental pollution, and reduce operational and financial losses.

The RSO shall be notified immediately of any accidents involving:

- Significant skin contamination.
- Ingestion of radioactivity by personnel.
- Unexpected personnel exposure.
- Severe contamination of equipment.
- Spread of contamination, or difficulty in cleaning up a contaminated area.
- The loss of radioactive materials or radiation producing machines.

9.1 Personnel Contamination

The RSO shall be immediately notified of any personnel contamination for evaluation of sustained exposure.

Take care of medical emergencies first. If health or life-threatening conditions exist, call 911 to reach campus dispatch. Decontamination can occur when the victim is in stable condition.

Notify persons in the area to assist you. Ask for radiation safety assistance.

For skin contamination, wash the contaminated area for two (2) minutes using a mild, pure soap and tepid (luke-warm) water. Pay particular attention to areas between fingers or around fingernails.

If the contamination is widespread, shower with mild soap and warm water, then resurvey to localize any remaining contamination.

If soap and water alone do not remove the contamination, repeat the two (2) minute wash up to three times unless the skin starts to turn red.

Once the contamination is localized, consider masking off the area with tape and cleaning with swabs. Rinse the contaminated area thoroughly, dry and count.

Contact the RSO as soon as possible.

Contaminated clothing should be bagged and turned over to EH&S Radiation Safety for storage to allow for radioactive decay, decontamination, or disposal.

9.2 Major Spill

A major spill is greater than 100 microcuries and may require state notification as determined by the RSO.

Follow the procedures on page 2 called Emergency Procedures for Spills of Radioactive Materials.

Follow the instructions of the RSO and/or the RSO's staff (e.g., decontamination techniques, surveys, provision of bioassay samples, requested documentation).

9.3 Minor Spill

A minor spill does not require state notification as determined by the RSO.

Follow the "SWIMS" procedure on page 2 called Emergency Procedures for Spills of Radioactive Materials.

9.4 Radiation Producing Machines

TURN OFF MACHINE. If possible, turn off the circuit breaker. Facilities may need to be called to turn off a circuit breaker.

Call 911 and ask for radiation safety assistance.

Notify the laboratory supervisor and/or the Radiation Authorized User.

Record all pertinent information about the incident including operating voltage and current, exposure time, and distance from the radiation source.

Appendix A
Statutes and Regulations

The following statutes and regulations and all amendments thereto are applicable to the use of radioactive materials at UCSC and are expressly incorporated as part of this Radiation Safety Manual:

Federal Statutes and Regulations

A. U.S. Atomic Energy Act of 1954.
B. U.S. Radiation Control for Health and Safety Act of 1968.
C. National Environmental Policy Act of 1969.
D. U.S. Atomic Energy Commission Regulations, Title 10, Code of Federal Regulations, Chapter I.
E. U.S. Food and Drug Administration, Department of Health, Education and Welfare Regulations, Title 21, Code of Federal Regulations, Chapter I, Subchapter J.
F. U.S. Department of Transportation Regulations, Title 49, Code of Federal Regulations, Chapter I, Parts 170 to 199.
G. U.S. Environmental Protection Agency Regulations, Title 40, Code of Federal Regulations, Chapter I.
H. U.S. Department of Labor, Title 29, Code of Federal Regulations, Part 1910.
I. Regulations of Other Miscellaneous U.S. Government Agencies, Code of Federal Regulations, Titles 14, 37, 39 and 46.

California Statutes and Regulations

A. California Health and Safety Code, Division 104, Part 9, Radiation.
B. California Radiation Control Regulations, Title 17, California Code of Regulations, Chapter 5, Subchapter 4.
C. California Radiologic Technology Regulations, Title 17, California Code of Regulations, Chapter 5, Subchapter 4.5.
D. Cal/OSHA, Title 8, California Code of Regulations.

Many of these codes and regulations are available for reference at EH&S Radiation Safety and at the Government Publications section of the McHenry library.

Appendix B
Bylaws of the Radiation Safety Committee

A. Authority

The Radiation Safety Committee (RSC) members are appointed by the Vice Chancellor for Research (VCR) to serve two-year terms that may be renewed. The RSC advises campus leadership and the Office of Environmental Health and Safety (EH&S) on campus policy. The RSC establishes programs and university policies on radiation safety.

The RSC is responsible for:

1. Oversight of the radiation safety program to provide assurance that all individuals who work with, or are in the vicinity of, radioactive material or radiation machines have sufficient training and experience to enable them to perform their duties safely, and in accordance with California regulations and the conditions of the license.
2. Reviewing processes that are intended to ensure that all uses of radioactive materials and/or RPMs are conducted safely, radiation doses are as low as reasonably achievable (ALARA) and in accordance with regulations.
3. Providing technical direction and information on campus radiation-safety policy to the Radiation Safety Officer (RSO) and investigators.
4. Annually reviewing the radiation safety and waste operations and procedures.[12] The RSC recommends remedial action to correct deficiencies identified in the radiation safety program.
5. Establish criteria, program elements, and provide oversight of the radiation safety program to provide assurance that all uses of radioactive material and/or radiation machines are conducted in a safe manner and in accordance with the State of California regulations and the conditions of the license.

B. Criteria for Committee Appointment

The RSC shall be composed of not more than 10 nor less than 5 members exclusive of ex-officio members. At least three members may be selected from the academic faculty, one from staff employees and one student, all of whom are knowledgeable of the principles and practices for the control of the hazards of radiation and experienced in the use of radioisotopes and/or radiation producing machines.
Every effort shall be made to have one member from each of the major academic disciplines that use radiation.

Activities of the RSC are directed by its Chairperson. The Chair of the RSC shall be a member of the Academic Senate. A Vice Chair may be voted in to act as a substitute for the Chair if they cannot officiate a meeting. The chair of the RSC may appoint subcommittees to examine and recommend approval or disapproval of RUA applications and renewals plus other duties as directed by the Chair and authorized in the license.

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[12] The review includes an examination of pertinent records, reports from the RSO, results of state inspections, written safety procedures, annual Radiation Safety Audit Report, and management-control systems. (EH&S provides whatever reports, summaries, and statistics the RSC may require for its review.)

Ex-officio technical support members include the Radiation Safety Officer, Director of Environmental Health and Safety, and other personnel as recommended by the RSO or RSC. Voting privileges for ex-officio members will be determined by the RSC in consultation with the RSO.

C. Responsibilities and Duties

1. Advisory to the VCR and EH&S.

The RSC reports to the VCR and advises the VCR and campus leadership on all matters relating to radiation safety. It also advises the office of EH&S in carrying out the Radiation Safety Program.

RSC members should be familiar with all pertinent California regulations, the terms of the license and information submitted in support of the request for the license and its amendments, as well as the contents of the Radiation Safety Manual.

2. Radiation Safety Manual

The RSC is responsible for the development of a Radiation Safety Manual, for its publication, distribution, and revision as necessary, which sets forth campus policy in radiation safety. The RSC will review all additions, deletions and changes and make recommendations for approval and/or adoption. The manual shall include policy statements on:

a. The scope of the radiation control program and the activities covered.
b. Procedures to be followed in obtaining authorization to acquire and use radioisotopes and radiation producing machines.
c. Regulations and procedures for the storage, transportation, and disposal of radioactive materials.
d. Responsibilities of the RUA Holder (RH) for the control of radiation hazards.
e. Maximum permissible radiation exposures to personnel.
f. Minimum requirements for personnel monitoring.
g. Minimum requirements for posting of radiation hazard warning signs.
h. Procedures to be followed in emergencies involving radiation.

3. Authorization for Radiation Use

The RSC reviews and recommends approval for the acquisition, possession and use of radioisotopes and/or radiation producing machines. In determining approval of applications for permits to use radioisotopes and/or ionizing radiation machines the applications shall be supported by documentary evidence of:

a. Adequate experience and training of the RH.
b. Proper and sufficient equipment and facilities.
c. Adequate plans and procedures for storage, handling and disposal of radioactive material.
d. Establishment of procedures to limit radiation exposure of personnel to as low as is reasonably achievable.
e. Assurance that the minimum amount of radioactive material is used to achieve desired results.

4. Review of Authorized Users

The RSC shall ensure that each RH's radiation use authorization is reviewed every year, with a detailed review of standard operating procedures and equipment every three years. If deemed necessary, the RSC may recommend a more frequent review schedule.

5. Review of Environmental Health and Safety Activities

The RSC reviews and gives advice on the Campus Radiation Safety Program and related activities of the Office of EH&S. The Office of EH&S shall provide such reports, summaries, and statistics as the RSC may require for its review. The Office of EH&S shall also bring to the attention of the RSC matters requiring changes in policy, standards, or regulations.

a. Ensure that the radioactive material license is amended, when necessary, before any changes in facilities, equipment, policies, procedures, and personnel.
b. Ensures that EH&S Radiation Safety resources are adequate for its assigned duties.
c. Review individual incidents and the radiation safety program to determine that all activities are being conducted safely and in accordance with California regulations and the conditions of the license. The review shall include an examination of pertinent records, reports from the RSO, results of California inspections, written safety procedures and management control system.
d. Recommend remedial action to correct any deficiencies identified in the radiation safety program.

6. Information and Training of Users

The RSC will serve as a source of information on radiological safety, will disseminate pertinent information to all users, or to individuals and will provide guidance in the training of users with regard to source materials, courses, and other means of improving the level of expertise.

The RSC will ensure that a program is established to ensure that all individuals whose duties may require them to work in the vicinity of radioactive materials or radiation producing machines (e.g., clerical, emergency response, campus police, maintenance, and building services personnel) are properly instructed as required by California Code of Regulations, Title 17, Section 30280.

7. Meetings

a. The RSC shall meet as often as required but at least quarterly for the purpose of reviewing radiation program activities and other matters related to the RSC charge.
b. Special meetings may be called to review Radiation Use Authorizations, review, act on radiation incidents, and/or consider matters referred by the Radiation Safety Officer or members of the RSC.
c. A quorum, consisting of a simple majority of the membership, shall be present at all meetings and will include the Radiation Safety Officer or designated alternate.
d. Individual matters or items requiring prompt action may be circulated electronically in the form of action memos for approval by a quorum.
e. Minutes of the meetings, actions, recommendations, and decisions shall be recorded and maintained by a member of the Office of EH&S.

Appendix C
Determination of the Hazard Guide Value (HGV)

The RUA's HGV is the sum of the individual HGVs for each listed radionuclide:

Individual radionuclide $HGV_i = HGV_{ext\text{-}i} + HGV_{int\text{-}i}$

$HGV_{ext\text{-}i} = Q_{vial}\, E_{group}\, P_i\, Eng_i$

Where:

Q_{vial} = Quantity of a radionuclide in millicuries vial limit

E_{group} = Group based on Gamma Constant

P_i = Possession factor based upon the maximum activity per isotope an RUA may possess

Eng_i = Weighting factor for engineering controls used

$HGV_{int\text{-}i} = ALI_i\, U_i\, Eng_i\, F_i$ or $(Q_{exp}/ALI)\, U_i\, Eng_i\, F_i$

Where:

ALI_i = Ratio of Q_{exp} to ALI (Q_{exp}/ALI)
Q_{exp} = Quantity of a radionuclide in millicuries experimental limit

ALI = Annual limit of Intake taken from 10 CFR 20 Appendix B U_i

= Use factor depending on type of experimental use

Eng_i = Weighting factor for engineering controls used

F_i = Weighting factor based on chemical form of material

The HGV is calculated for each radionuclide and the product of the sum of the individual radionuclides HGVs and Assessment Factor is the total HGV value assigned to the RUA.

Total RUA $HGV = A_i\, \Sigma\, (HGV_{ext\text{-}i} + HGV_{int\text{-}i})$
Where:

A_i = Assessment factor based on the labs performance history

Factors Used in HGV Formula

The factors used in the HGV formula are described further below:

- ❑ Q_{exp} = **Quantity of the radionuclide** is based on the Experimental Limit (millicuries).
- ❑ Q_{vial} = **Quantity of the radionuclide** is based on the Per Vial (shipment) Limit (millicuries).

- **External Hazard Group Factor (E_{group})** is primarily based on the gamma constant of the radionuclide. Neutron and pure beta emitters are also described below:

Gamma Constant (R-cm^2/hr-mCi)	E_{group}
$\beta < 1$ MeV	0.1
$\beta \geq 1$ MeV; $\Gamma \leq 1$	1
$1 < \Gamma \leq 5$	5
$5 < \Gamma \leq 10$	10
$\Gamma > 10$, any neutron emitters	25

- **Possession Factor (P_i)** is based on the total possession limit of the isotope:

Possession Factor	Pi
$\leq$ 10 mCi	1
10 mCi < Possession $\leq$ 50 mCi	2
50 mCi < Possession $\leq$ 100 mCi	5
Possession > 100 mCi	10

- **ALI Ratio Factor (ALI_i)** is based on ratio of **Q_{vial}** to **ALI = Q_{vial} / ALI**

For most isotopes, the lowest ALI is used. A listing of all the ALIs is on the "Data" sheet of the HGV calculator. Isotope generators are listed as Xx-Yy, where Yy is the daughter and the isotope used for calculations. For some isotopes, where the lowest ALI was very rarely encountered, the typical route of exposure ALI was used instead. Examples: ingestion ALI as opposed to inhalation for ^{32}P, U/Th-Acetates and Nitrates, ^{210}Po, others can be adjusted as needed.

- **Use Factor (U_i)** is based on the proposed use of the radionuclide:

Type of Operation	Typical Use Factor (U)
Simple wet operations, source handling (e.g., dilution, transfers, closed systems with appropriate traps used in hoods)	0.1
Normal chemical operations (e.g., chromatography, filtration, centrifugation, animal injections)	1.0
Simple dry operations, transfer and manipulation of dispersible material, complex wet operations, or DNA precursors	10.0
Production and use of volatile material; complex dry operations (e.g., crushing, mixing)	100.0

- **Engineering Factor (Eng_i)** is based on the engineering controls required; note only the hot cell provides any external protection. All others are considered to have Eng_i =1for $HGV_{ext.}$

Engineering Control	Engi (Int/Ext)
Glove box	0.01/1.0
Hot Cell	0.01/0.01
Fume Hood	0.1/1.0
Open Bench-top	1.0/1.0

- **Form Factor (F_i)** is based on the chemical form:

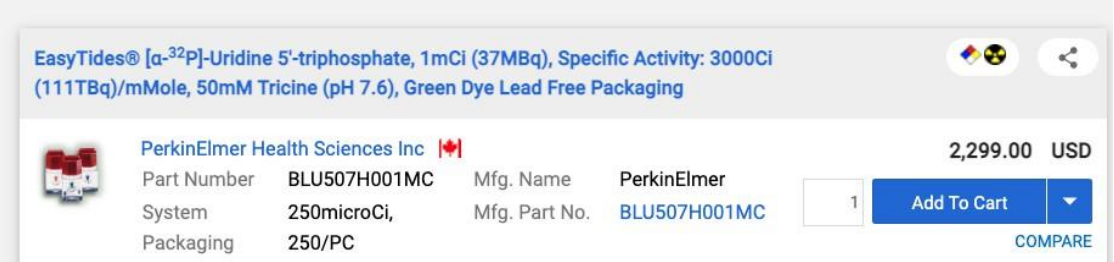
Chemical Form	Fi
Sealed sources	0.001
Thin window sealed sources, solid sources	0.1
Liquid	1.0
Powders, gases, volatile compounds	10.0

- **Assessment factor (Ai)** recognizes the performance history of the laboratory. If there is no prior history, the assigned value is 1. The RSO is responsible for assigning this value as follows:

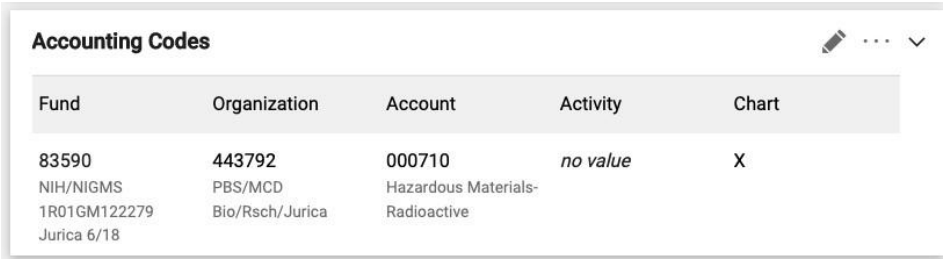
Status	Compliance	Assessment factor
Outstanding Laboratory	No issues	0.1
Good Laboratory	Minor issues	0.5
Average Laboratory	Average	1.0
Below Average Laboratory	Below Average	2
Poor Laboratory	Poor performance	5

Appendix D
Procurement

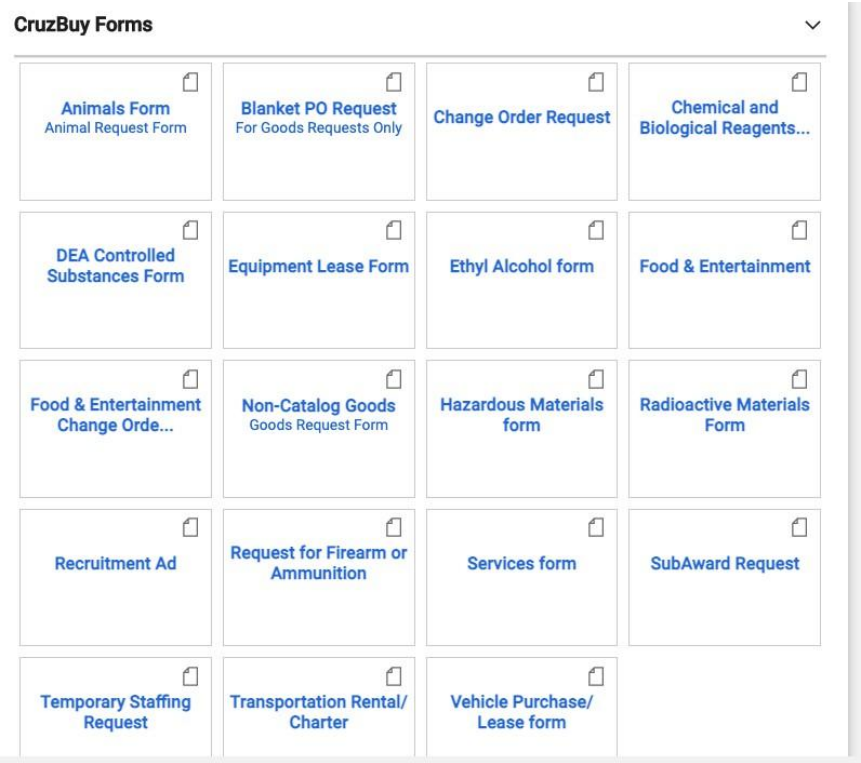
Radioactive materials must be ordered through CruzBuy. Items in a hosted catalog will be marked as radioactive materials and can be added directly to a cart.



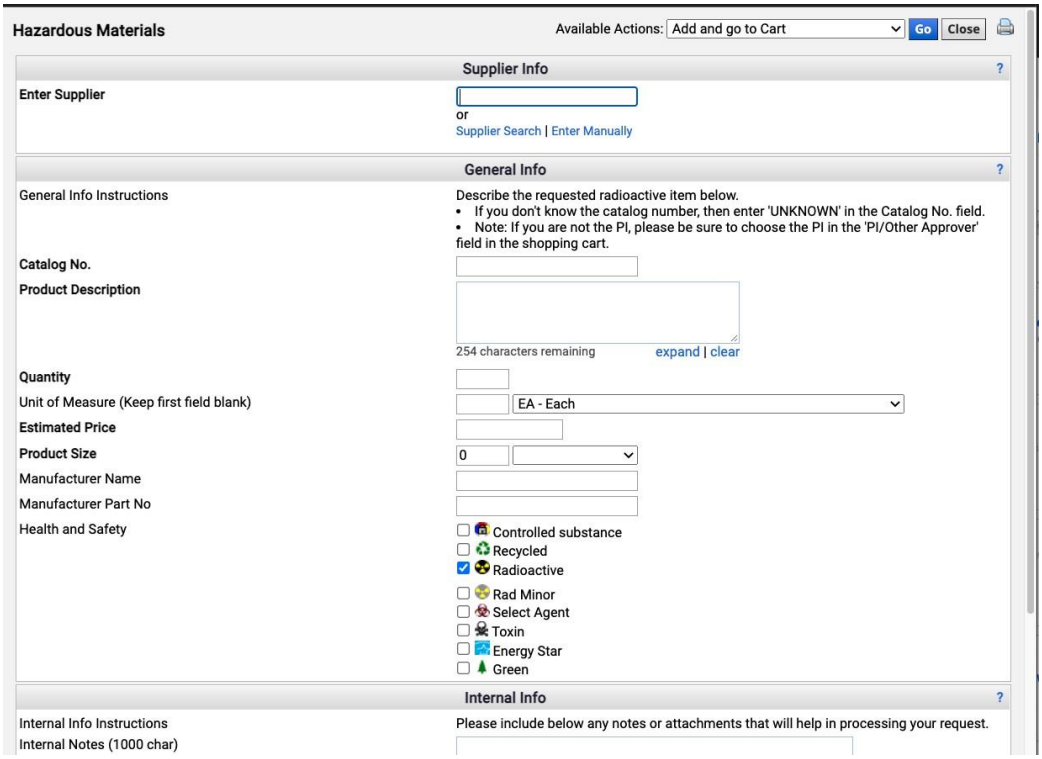
Before submitting the requisition, ensure that the accounting code "Account" is listed as 000710 for Hazardous Materials- Radioactive.



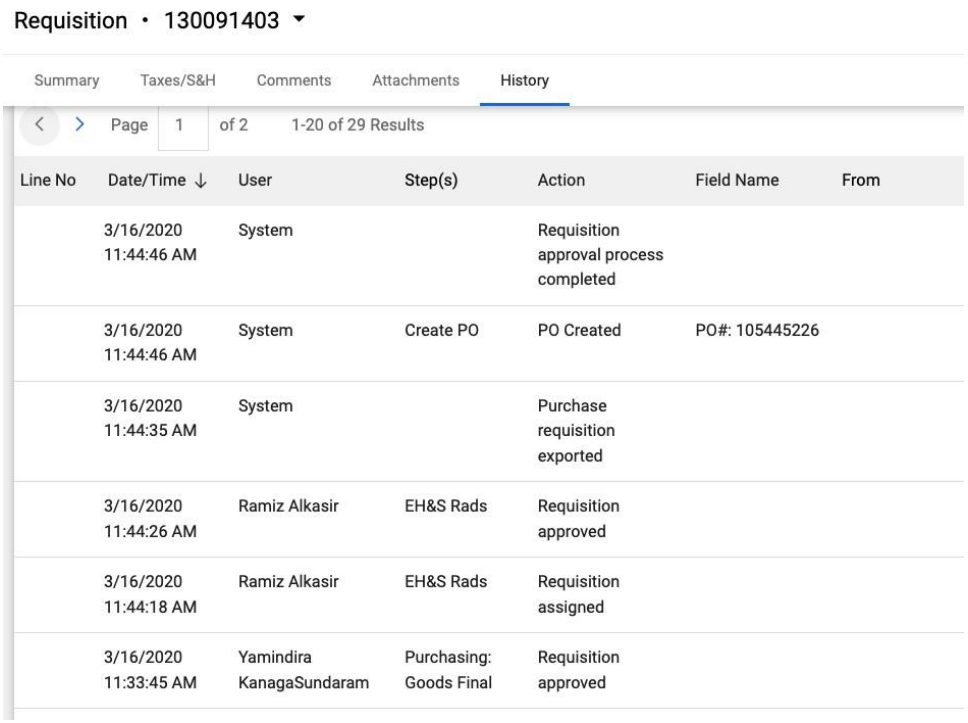
For items not in a hosted catalog (non-catalog goods), use the Radioactive Materials Form.



This form has the radioactive hazard pre-checked.



After submission, the requisition will go through a series of approvals by accounting and the purchasing office. The radiation safety office is automatically notified and must provide approval before a purchase order for the items will be created. The approvals can be monitored in the “History” tab for the requisition.



Requisition • 130091403

Summary | Taxes/S&H | Comments | Attachments | History

Page 1 of 2 1-20 of 29 Results

Line No	Date/Time ↓	User	Step(s)	Action	Field Name	From
	3/16/2020 11:44:46 AM	System		Requisition approval process completed		
	3/16/2020 11:44:46 AM	System	Create PO	PO Created	PO#: 105445226	
	3/16/2020 11:44:35 AM	System		Purchase requisition exported		
	3/16/2020 11:44:26 AM	Ramiz Alkasir	EH&S Rads	Requisition approved		
	3/16/2020 11:44:18 AM	Ramiz Alkasir	EH&S Rads	Requisition assigned		
	3/16/2020 11:33:45 AM	Yamindira KanagaSundaram	Purchasing: Goods Final	Requisition approved		

Appendix E
Responsibilities of the Radiation Safety Officer (RSO)

The RSO administers the EH&S Radiation Safety Program under the general direction of the RSC. RSO duties include the following:

1. Communicates the federal/state requirements for the safe use of radiation.
2. Prepares a Radiation Safety Manual to serve as a statement of UCSC policy and practice regarding the use of ionizing radiation.
3. The liaison between UCSC and federal/state regulatory agencies.
4. Directs the functions of EH&S Radiation Safety.
5. Oversees radioactive waste disposal activities.
6. Reviews applications for new or modified uses of radioactive materials and radiation producing machines prior to their use.
7. Reviews projects and inspects facilities to determine the level of compliance with the pertinent regulations and any conditions specified by the RSC.
8. Investigates incidents and, where necessary, directs corrective action.
9. Develops emergency response plans, operational procedures and coordinates radiation related activities during an emergency.
10. Provides services through EH&S Radiation Safety, including personnel and area monitoring, instrument calibration, waste disposal, facility design and project planning when radioactive materials and radiation producing machines are involved.
11. Maintains appropriate records of EH&S Radiation Safety operations for inspection by appropriate agencies.
12. Conducts or develops radiation safety training programs and updates.
13. Annually reviews or delegates the review of the radiation safety program content and implementation.
14. Serves as secretary to and maintains records for the RSC.
15. Carries out activity assigned by the RSC.
16. The RSO, if other than the Director, shall make periodic reports to the Director of EH&S.

Appendix F
Functions of EH&S Radiation Safety

1. General surveillance of all health physics activities, including both personnel and environmental monitoring.
2. Provide consulting services to personnel at all levels of responsibility on all aspects of radiation protection.
3. Receive and inspect all radionuclides that come to UCSC and consult on all packages of radionuclides shipped from UCSC.
4. Inspect all machines capable of producing ionizing radiation annually, or as requested/needed.
5. Provide a personnel monitoring service as required, and maintain records of personnel exposure/uptake. Notify individuals and their supervisors of doses approaching or exceeding the UCSC Administrative Guidelines and recommend appropriate remedial action.
6. Develop radiation safety training materials and assist with the training of university personnel who use radioactive materials or assign online training. Topics shall include basic radiation safety topics as required by regulations.
7. Oversee the radioactive waste disposal program (includes pickup, storage, shipment, and maintaining disposal records).
8. Perform sealed source leak tests as required.
9. Maintain an inventory of all radioactive materials located at UCSC, or its associated facilities.
10. Supervise decontamination efforts as required.
11. Maintain a program of environmental monitoring/remediation for radiation hazards.
12. Prepare radiation use applications/amendments for review by the RSC.
13. Review RUAs on a frequency set forth in the original approval.

Appendix G
Responsibilities of the Radiation Permit Holder (RH)

The RH is personally responsible for compliance with the Radiation Safety Manual's requirements as they pertain to the authorized use of radiation. Specific responsibilities include:

1. Apply to the RSC for authorization to use sources of ionizing radiation.
2. Prepare a plan before an experiment is conducted in order to determine the appropriate types and amounts of radiation or radioactive material necessary for the procedure. This will provide an indication of the level of protection required. Before a protocol is implemented, it may be desirable to do a dry run that will help to identify any unexpected problems. If problems are encountered, contact the RSO before initiating the procedure.
3. Maintenance of current records regarding:
   a) Receipt, use and disposal of radionuclides.
   b) Monitoring of laboratories and workplaces including contamination levels and exposure data.
   c) Training of personnel engaged in radionuclide use under their jurisdiction.
4. Have required records available for inspection at reasonable times by the RSO or the State CDPH-Radiologic Health Branch.
5. Ensure personnel under the RH's supervision are trained. This training shall include the requirement to read and understand:
   a) The appropriate Radiation Use Authorizations
   b) Pertinent laboratory instructions for the use of radionuclides
   c) The State Notice to Employees - Standards for Protection Against Radiation
   d) Where the campus Radiation Safety Manual can be found and how to contact Radiation Safety staff to answer their questions on proper radiation safety procedures.
   e) The proper procedures for the control of radiation hazards and limiting exposure to others according to the type of radioactive materials being used.
6. Ensure ancillary personnel that enter areas controlled by the RH are trained. This training shall include:
   a) The requirement to read and understand postings and emergency procedures. The State of California Notice to Employees - Standards for Protection Against Radiation
   b) The particular hazards and hazard areas within the laboratory.
   c) The general ancillary training material provided by EH&S Radiation Safety.
7. Inform the RSO when individuals, activities, or locations covered by an RUA are changed.
8. Implement approved procedures for the procurement of radioactive materials by purchase or transfer.
9. Post areas where radioactive materials are stored or used.
10. When required, post areas where radiation exposures exist.
11. Properly record the receipt, transfer and disposal of radioactive material, including sealed sources.
12. Properly store and prepare radioactive waste for collection by EH&S.
13. Enforce the submission of any required bioassay samples or keeping appointments for required body or organ counting.

14. Conduct surveys of workplaces where authorized use of ionizing radiation is performed and document the results of these surveys. Maintain these records in the lab and available for review by EH&S staff or CDPH inspectors.
15. Maintain work areas free of removable contamination and providing personnel for decontamination operations.
16. Minimize the stock of stored radioactive materials within the work/laboratory area.
17. When terminating a RUA:
    a) Transfer excess radioactive materials and personnel monitoring devices to EH&S Radiation Safety.
    b) If radioactive waste is present, arrange for a pickup with EH&S Radiation Safety.
    c) Conduct a lab survey to ensure that the area is free of contamination.
    d) Request that EH&S Radiation Safety performs a closeout survey before leaving the campus.
    e) Ensure that access to the Radiation Safety Manual and other relevant documents are available to all personnel engaged in work with ionizing radiation (electronic access).
    f) Enforce the use of personnel monitoring devices, survey meters, personnel protective equipment, and engineering controls as specified in the Radiation Safety Manual or by the RSC.
    g) Notify EH&S Radiation Safety promptly in cases of personnel contamination or potential radiation exposure accidents or after any unusual event that results in contamination of work areas or release of a radioisotope or radiation beyond the confines of the authorized work areas.

Appendix H
Responsibilities of the Radiation User (RU)

Radiation Users who handle radioactive materials or use radiation producing machines are responsible for their own safety and the safety of those around them by:

1. Following procedures/protocols and ensuring that training and safety equipment, etc., are adequate. Check with the RH or RSO if there are questions.
2. Keeping exposure to radiation as low as reasonably achievable, but also below the UCSC Administrative Guidelines specified in this manual.
3. Minimizing airborne radioactive contamination by use of available engineering controls such as fume hoods.
4. Wearing personal protective equipment (PPE).
5. Wearing prescribed monitoring equipment, such as whole body badges and ring badges when required.
6. Informing the RH and/or RSO of any unsafe conditions known to exist.
7. Observing radiation control techniques.

The following are general procedures for radiation control in a radioisotope laboratory. Since each laboratory has special requirements, it is difficult to establish one set of procedures for all situations; however, with slight modifications the following can satisfy most needs:

a) Radiation work and storage areas must be separated from general personnel spaces.
b) Personal belongings other than those required for work should kept away from the radioactive work area.
c) Eating, drinking, smoking, and application of cosmetics in the laboratory are forbidden.
d) Cover all radioactive material work areas with absorbent paper as a protection against spillage.
e) Provide necessary shielding.
f) Place radiation waste materials in containers as specified in the Radiation Safety Manual.
g) Maintain good housekeeping throughout the laboratory.
h) Restrict against all possible personal contamination by:
    - Wear rubber gloves and use tongs.
    - Use remote pipetting techniques.
    - Do not work when open skin wounds can be contaminated.
    - Not eating or drinking in laboratory spaces.
    - Wear lab coats, safety glasses, gloves in addition to long pants, and closed toed shoes.
i) Clearly mark all contaminated glassware or equipment until it has been decontaminated.
j) Restrict volatile materials to special fume hoods, and powders to glove boxes.
k) Keep all intermediate levels of radioactive materials away from counting areas.
l) Label with the caution trefoil symbol all radioactive material work areas, materials, and/or containers.
m) Learn what instruments are effective for monitoring, and how to use them. Then monitor any suspect equipment or operation to ensure safety. You cannot know it is safe unless you have monitored it.

n) If, in the course of work, contamination is suspected, check with a suitable survey meter or by means of an "area wipe" and decontaminate if necessary.
o) Wash hands and check with a suitable survey meter before leaving laboratory.

Additional Requirements for High Hazard Procedures

1. Preplan operation in detail:
   a) Provide shielding as required.
   b) Predetermine action in case of emergencies.
   c) Develop personnel qualifications to satisfy the special needs of the project.
2. Inform personnel working with radioactive materials (and those who could be affected by incidental exposure or accidents) of safety practices and emergency procedures.
3. Use appropriate laboratory facilities and equipment.
4. Restrict procedures to one radioisotope and one operation at a time whenever possible. Avoid simultaneous and conflicting hazardous situations.
5. Monitor all areas and operations routinely with a radiation survey meter and/or wipe tests.

Appendix I
Forms

The most current forms can be found on the EH&S Radiation Safety website - https://ehs.ucsc.edu/programs/research-safety/radiation/index.html

- **RUA Application Radioactive Materials**
- **X-Ray Use Authorization Application**
- **Standard Operating Procedures**
- **Statement of Training and Experience**
- **Authorization to Release Personnel Dosimetry Records**
- **RUA Amendment Request**
- **RUA: Radiation Use Authorization**
- **Personnel Monitoring Record**
- **Prenatal Radiation Exposure Risks and Precautions**
- **Notification of Status as a Declared Pregnant Worker**

Appendix J
Animal Use

For all program proposals using radioactive materials in animal research, an integral part of the consideration for approval will be the Principal Investigator's assurance of safe handling and disposal of radioactive materials in biological specimens.

The Institutional Animal Care and Use Committee (IACUC) adopts the NIH Guide for the Care and Use of Laboratory Animals in Research [HEW (NIH) 78-23, revised 1978]. Part H of the Guide, "Special Requirements for Radiation Safety," is to be considered as part of this manual as are the General Instructions for Animal Caretakers given below.

Where animal studies are involved, special care by animal caretakers and technical personnel is required to be certain of compliance. Specific instructions may be recommended by the RSC and will accompany approval of usage by the RSO and the Campus Veterinarian.

GENERAL INSTRUCTIONS FOR ANIMAL CARETAKERS

General instructions for animal caretakers are listed below. Specific instructions will depend on the program, isotope, levels of activity, frequency of use and number of animals.

1. No animal use involving radioactive materials will occur without prior review by IACUC, the RSC and approval by the RSO. Approval is partly contingent on assurances that adequate provision has been made for waste disposal and that appropriate instructions relevant to that particular isotope and use have been given to the animal caretakers and technicians.
2. All disposals will be through or under the supervision of the Radiation Safety Officer who will outline appropriate arrangements to guarantee compliance.
3. All equipment housing biological specimens will be placed in isolated areas or quarters, with the appropriate radiation sign(s) displayed.
4. Racks and cages housing animals administered radioactive materials will be so labeled. Information on the outside of the cage will include the date of administration, the isotope and the quantity administered.
5. Animals producing excreta having detectable radioactive activity are to be separated from those that do not.
6. Animal caretakers must be aware of specific instructions outlined in the usage proposal and any recommendations supplemented by the RSC.

Regular inspections will be carried out by the RSO and, when required, training sessions will be held by appropriate personnel assigned by the Director of EH&S and in cooperation with the Campus Veterinarian to ensure proper handling of radioactive materials by technicians, animal caretakers and supervisory pe Radioactive materials must be ordered through CruzBuy.

Items in a hosted catalog will be marked as radioactive materials and can be added directly to a cart.

Appendix K
Glossary of Terms

Airborne Radioactive Material

Radioactive material dispersed in the air in the form of fumes, mists, vapors, or gases. [10 CFR 20.1004]

ALARA (As Low As Reasonably Achievable)

Making every reasonable effort to maintain exposures to radiation as far below the dose limits as is practical consistent with the purpose for which the licensed activity is undertaken, taking into account the state of technology, the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations and in relation to utilization of nuclear energy and licensed materials in the public interest. [10 CFR 20.1003]

Ancillary Personnel

Individuals who have a job related need to enter a controlled area to accomplish their job duties. For purposes of radiation protection, also a Member of the Public. Examples include clerical, emergency response, campus police, maintenance, and building services personnel.

Byproduct Material

Radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or using special nuclear material (Nuclear fission products). Material with atomic numbers 1-83 (bismuth and lighter elements), and 84-96 (excluding uranium, thorium, or plutonium) as defined by the NRC is byproduct material. The Energy Policy Act, defines byproduct material more broadly in sections 11e of the act.

Cabinet X-Ray Machines

Machines constructed such that the useful beam is completely contained within a shielded cabinet, room, or other enclosure from which humans are excluded when the beam is on. This does not include medical machines and X-ray diffraction and fluorescence analysis machines.

Controlled Area

Controlled area means an area, outside of a restricted area but inside the site boundary, access to which is limited by the licensee for any reason. [10 CFR 20.1003]

At UCSC, all areas (rooms) designated for use or storage of radioactive materials or operation of radiation producing machines within are designated controlled areas. Non-occupationally exposed individuals may be present in these areas, either escorted or as Ancillary Personnel.

Note:

UCSC permits members of the public to have access to controlled areas, the limits for members of the public continue to apply to those individuals.

Curie

A unit of radioactivity. One curie is the quantity of radioactive material corresponding to a disintegration (radioactive transformation) rate of 3.7×10^{10} per second (s^{-1}).

CDPH (Department of Public Health)

Reference to CDPH means the California State Department of Public Health

Dose

Dose or *radiation dose* is a generic term that means absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, or total effective dose equivalent, as defined in other paragraphs of this section. [10 CFR 20.1003]

Declared Pregnant Worker

A worker who has voluntarily informed the licensee of her pregnancy and the estimated date of conception in writing. The declaration remains in effect until the declared pregnant worker withdraws the declaration in writing, or is no longer pregnant. [10 CFR 20.1003]

Radiation User (RU)

An individual who is listed on an RUA as a user of radiation and has been properly trained to use the sources being used.

Electron Microscope

A device that visualizes matter via interaction with high-speed electrons (5-500 kiloelectron volts). This includes both scanning and transmission type units regardless of accelerating voltage.

EH&S

Environmental Health and Safety at UCSC.

Engineering Controls

Safety features included as an integral part of a lab or other facility. Examples include increased ventilation, fume hoods, radiation shielding, safety interlocks, etc.

Exempt Source

A source, typically a consumer product containing byproduct material that are used by the general public and is exempted from licensing requirements only if the Nuclear Regulatory Commission determines that the products or types of uses do not constitute an unreasonable risk to public health and safety and the environment.

Fail-Safe:

A term that describes a type of design. A fail-safe indicator or light is designed such that, if it fails, the action, which it indicates, will automatically cease. Example: If a fail-safe "X-ray on" light burns out, the fail-safe feature will sense the light failure, and cause the X-ray function to terminate.

Generally Licensed Device

A device that is designed with inherent radiation safety features so that it can be used safely by persons with no radiation training or experience. A typical generally licensed device consists of radioactive material contained in a sealed source within a shielded device, such as gas chromatograph units, fixed gauging devices, static eliminators, luminous exit signs, calibration or reference standards, some ice detection devices and in vitro laboratory kits. The distributor holds the distribution license so that a case-by-case determination of the adequacy of the radiation training or experience of each user is not necessary. See section 3.1.3

Hazard Guide Value (HGV)

Hazard Guide Value is a calculation performed by the RSO or a program health physicist to assess the risk associated with the planned work. The procedure used for this assessment shall follow the UC system-wide guidance on Hazard Guide Values. See Appendix C. **High Radiation Area**

An area, accessible to individuals, in which radiation levels from radiation sources external to the body could result in an individual receiving a dose equivalent in excess of 0.1 rem (1 mSv) in 1 hour at 30

centimeters from the radiation source or 30 centimeters from any surface that the radiation penetrates. [10 CFR 20.1003]

Human Use

The internal or external administration of radiation or radioactive materials to human beings. [17 CCR §30100]

Ionizing Radiation

Ionizing radiation means gamma rays and X-rays; alpha and beta particles, high speed electrons, neutrons, protons, and other nuclear particles; but not sound or radio waves, or visible, infrared or ultraviolet light. [17 CCR §30100]

Lab Contact

Any member of a research group, named by the RH as the point of contact for matters involving radiation use under a specific authorization.

Member of the Public

Any individual except when that individual is receiving an occupational dose. [10 CFR 20.1003]

Medical Machine

A device used to deliberately expose humans or animals to ionizing radiation for the purpose of medical diagnosis or treatment. This classification is determined by use rather than design.

Minor

An individual less than 18 years of age. [10 CFR 20.1003]

NCRPM

National Council of Radiation Protection and Measurement

NRC

The Nuclear Regulatory Commission or its duly authorized representatives. [10 CFR 20.1003]

Non-Occupational Dose

The dose received by an individual (from UCSC sources) who does not work directly with radiation (e.g., office worker, maintenance person, building services person, student, contractor, visitor, etc.). See **public dose**.

Occupational Dose

The dose received by an individual in the course of employment in which the individual's assigned duties involve exposure to radiation or to radioactive material from licensed and unlicensed sources of radiation, whether in the possession of the licensee or other person. Occupational dose does not include dose received from background radiation, from any medical administration the individual has received, from exposure to individuals administered radioactive material and released in accordance with 10 CFR 35.75, from voluntary participation in medical research programs, or as a member of the public. [10 CFR 20.1003]

Personnel Monitoring Equipment

Devices designed to be worn or carried by an individual for the purpose of measuring the dose received by that individual (e.g., film badges, pocket chambers, pocket dosimeters, film rings, etc.).

Personal Protective Equipment (PPE)

Safety equipment used by an individual to protect him/herself from expected or unexpected hazards associated with a procedure. Examples include gloves, goggles, shoe covers, respirators, etc.

Public Dose

The dose received by a member of the public from exposure to radiation or radioactive material released by a licensee, or to any other source of radiation under the control of a licensee. Public dose does not include occupational dose or doses received from background radiation, from any medical administration the individual has received, from exposure to individuals administered radioactive material and released in accordance with 10 CFR 35.75, or from voluntary participation in medical research programs. [10 CFR 20.1003]

Radiation

See **Ionizing Radiation.**

Radiation Area

An area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.005 rem (0.05 mSv) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates. [10 CFR 20.1003]

Radiation Producing Machine (RPM)

Any device capable of producing (ionizing) radiation when the associated control devices are operated, but excluding devices which produce radiation only by the use of radioactive material. [17 CCR §30100] All machines that produce ionizing radiation including electron microscopes, cabinet X-ray, x-ray fluorescence, x-ray diffraction, x-ray tubes, electron beam devices, particle accelerators and including medical x-ray (human or animal use) and Computed tomotgraphy (CAT) scanners are considered Radiation Producing Machines.

Radiation Safety Committee (RSC)

A committee appointed by UCSC administration, and granted authority by the State of California to authorize and control the use of radiation at UCSC.

Radiation Safety Officer (RSO)

An individual appointed by the RSC and UCSC administration to manage the Radiation Safety Program at UCSC.

Radiation Sources

Radiation Producing Machine or Radioactive Material.

Radiation user (RW)

Either an individual qualified to enter restricted and/or controlled areas by virtue of training and authorization on one or more RUAs or an individual qualified in the course of employment, a contractor or academic role (a student, graduate student, post-doctoral traineeship), or in which the individual's assigned duties involve potential exposure to radiation or to radioactive material from licensed and unlicensed sources of radiation, whether in the possession of the licensee or other person.

Radiation Use Authorization (RUA)

An authorization to use radiation, granted by the RSC to an RH.

Radioactive Material

Radioactive material means any material which emits ionizing radiation spontaneously. [17 CCR §30100]

Radionuclide

Any material (solid, liquid, or gas) that emits ionizing radiation spontaneously.

Rem

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 Seivert). [10 CFR 20.1004]

Research and Development

Theoretical analysis, exploration, experimentation or the extension of investigative findings and scientific or technical theories into practical application for experimental or demonstration purposes, including the experimental production and testing of models, prototype devices, materials and processes; but shall not include human use. [17 CCR §30100]

Restricted Area

Restricted area means an area, access to which is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials. [10 CFR 20.1003]

At UCSC, restricted areas are generally located within rooms designated as controlled areas. Only occupationally exposed Radiation Users are permitted access to these areas, unless escorted by radiation safety staff, for a specific purpose.

RH

The Radiation Use Authorization Holder is the individual person in charge, professional staff or a faculty member or, who has been authorized by the RSC and granted a Radiation Use Authorization.

Rotational Student (RS)

A special category of UCSC students who are undergoing quarterly assignment to different research laboratories for familiarization prior to selecting a laboratory for their tenure at UCSC. These students work under closer supervision than Radiation Users and are considered "trainees" and not regular members of the laboratory.

Sealed Source

Any radioactive material that is encapsulated in such manner that the radioactive material will not be released under the most severe conditions likely to be encountered during normal use.

Shall

Indicates a requirement. Compliance is mandatory.

Should

Indicates a recommendation. Compliance would significantly enhance safety.

Source Material

(1) Uranium or thorium or any combination of uranium and thorium in any physical or chemical form; or

(2) Ores that contain, by weight, one-twentieth of 1 percent (0.05 percent), or more, of uranium, thorium, or any combination of uranium and thorium. Source material does not include special nuclear material.

Special Nuclear Material

(1) Plutonium, uranium 233, uranium enriched in the isotope 233 or in the isotope 235, and any other material which the Department declares by rule to be special nuclear material after the United States Nuclear Regulatory Commission, or any successor thereto, has determined the material to be such, but does not include source material; or

(2) Any material artificially enriched by any of the foregoing, but does not include source material.

State

Reference to the State means the State of California and any of its agencies empowered to establish regulations regarding radiation and/or radioactive materials.

Survey

An evaluation of the radiation hazards related to the production, use, release, disposal, or presence of radiation sources under a specific set of conditions. Often the evaluation includes a physical survey of the radiation source and its surrounding area using monitoring/sample collection techniques suitable for evaluating radiation exposures/doses and/or the quantity of radioactive material present.

University of California Santa Cruz (UCSC)

The term "UCSC" refers to all locations that are under the administrative control of the Chancellor of the University of California Santa Cruz Campus.

Unrestricted Area

An area, access to which is neither limited nor controlled by UCSC. [10 CFR 20.1003]

X-Ray Diffraction (XRD) and Fluorescence Analysis Machines (XRF)

Machines that produce X-ray beams to analyze various substances via X-ray diffraction or X-ray stimulated fluorescence.