RADIATION SAFETY MANUAL

MAR 2021

USC University of Southern California

Office of Environmental Health and Safety

https://ehs.usc.edu

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Pg. 4.1	• Occurrences of *iStar* throughout section hyperlinked to referential web page.
Pg. 4.3	• *RSC web page* hyperlinked to referential EH&S web page. • *21 CFR 361.1.* hyperlinked to referential web page.
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Pg. 7.1	• Newly updated and reformatted Radiation Emergency Procedures icon replaced old figure.
Pg. 8.2	• **Waste Containers** section placed after **DECAY-IN-STORAGE (DIS) PROGRAM**.

Sections 10.0 - 12.0

Pg. 10.7	• Sentence "Please refer to "Registration of X-ray Producing Devices" for more details." revised to "Refer to X-ray Producing Device Registration Fact Sheet [hyperlink] for details; refer to the X-ray Safety Manual [hyperlink] for safety information."
Pg. 10.9	• Sentence "See Figure 10.10, Radiation-Producing Devices Registration Fact Sheet" revised to "See Figure 10.10, X-ray Producing Device Registration Fact Sheet [hyperlink]." • New X-ray Producing Device Registration Fact Sheet illustration placed in Figure 10.10 with new hyperlink.
Pg. 10.10	• *iStar* hyperlinked to referential web page.

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Pg. A.1	• Revised and new fact sheets/guide sheets added to section with corresponding hyperlinks.
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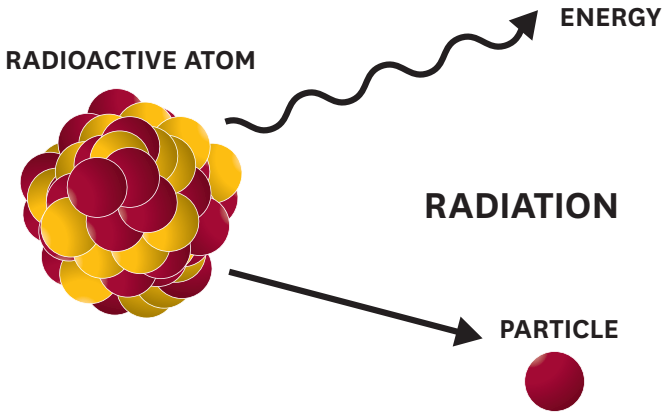
1.0 Purpose and Scope

The Radiation Safety Program at the University of Southern California builds the framework for creating a safe working environment for faculty, staff, students, and volunteers that may be exposed to ionizing radiation. Radiation is considered "ionizing" when the energy is high enough to displace an electron from an atom, thereby creating an ion which can break existing molecular bonds. Examples of ionizing radiation used at USC include:



Radioactive materials that spontaneously emit any of the following:

- Alpha particles
- Beta particles (electrons and positrons)
- Neutrons
- Gamma Rays
- X-rays

Devices that produce ionizing radiation (usually X-rays) when energized such as:

- Clinical X-ray machines
- Fluoroscopes
- Bone Densitometers
- X-ray Diffractometers
- Cabinet X-ray machines
- Irradiators
- Electron Microscopes
- Particle Accelerators

This Radiation Safety Manual contains procedural guidelines and information for prudent work practices while using any of these materials or devices at USC. The manual is available online. The procedures in this manual are in accordance with USC policies and California regulations. The California Radiation Control Regulations are available at CCR Title 17, Subchapter 4. Radiation.

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2.0 Regulatory Requirements

The USC Radiation Safety Program is based on state and federal laws that regulate the handling of radiation devices and/or radioactive materials.

State

California Code of Regulations (CCR)
Title 17, Subchapter 4. Radiation

Federal

Several federal regulations are incorporated by reference in 17 CCR. They include:

- "Standards for Protection Against Radiation" - Title 10 Code of Federal Regulations Part 20 (10CFR20),
- "Medical Use of Byproduct Material" (10CFR35),
- "Packaging and Transportation of Radioactive Materials" (10CFR71 and 49CFR107, 171-180, and 390-397).

USC maintains a "broad scope license" to possess and use radioactive materials as issued by the State of California Department of Public Health (CDPH).

Under the provisions of the license, USC is required to maintain a well-managed and documented program to ensure that radioactive materials are used safely. Additionally, the license delegates responsibility to the Radiation Safety Committee (RSC) for authorizing qualified individuals to use radioactive materials.

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3.0 Roles and Responsibilities

USC's official Injury and Illness Prevention Policy and Research Personnel Protection Policy lay out the health and safety roles and responsibilities of the various members of the USC community (https://policy.usc.edu/injury-prevention/ and https://policy.usc.edu/research-personnel-protection/). It is recommended that all USC persons (especially PIs and other supervisory personnel) read and understand these policies.

Research Safety Oversight Committee (RSOC)

The RSOC:

- Has the following members:
  - Vice President for Research - Chair
  - EH&S Director
  - Chairpersons of other USC-wide safety committees
  - USC senior managers
- Provides high-level oversight of all aspects of health and safety at USC.
- Facilitates communication between the specialized safety committees:
  - Institutional Biosafety Committee (IBC)
  - Radiation Safety Committee (RSC)
  - Campus-Wide Chemical Safety Committee (CCSC)
- Reports administratively to the USC Provost and President.

Radiation Safety Committee (RSC)

The Radiation Safety Committee (RSC) is responsible for ensuring that radioactive materials and radiation-producing devices are used safely and in accordance with State and Federal regulations. The RSC members are appointed by the Senior Vice President for Administration.

It is the responsibility of the RSC to:

- Formulate general policy governing the use of radiation-producing devices and radioactive materials;
- Review and approve all requests for the use of radiation-producing devices and radioactive materials;
- Determine that all individuals authorized to use radiation-producing devices and radioactive materials have sufficient training and experience to enable them to perform their duties safely;
- Establish a program to ensure that all individuals whose duties may require them to work in the vicinity of radioactive material or radiation-producing devices are properly instructed about all appropriate health and safety matters; and

- Conduct an annual review of the Radiation Safety Program to determine that all activities are being conducted safely and in accordance with California Radiation Control Regulations and the university's radioactive materials license.

The RSC has the authority to:

1. Disapprove all proposals that do not meet the university policies or the federal, state or county regulations;
2. Terminate the use of radioactive materials by individuals who do not comply with all federal, state or county regulations; and
3. Apply other restrictions on the use of radioactive materials and radiation-producing devices to comply with all regulations and policies.

The Radiation Safety Committee meets at least once each quarter. Membership includes:

- Representative of the administration;
- Radiation Safety Officer;
- Physicians with expertise in the use of radioactive materials and radiation-producing devices for patient diagnosis and therapy;
- Individuals with expertise in the use of radioactive materials or radiation-producing devices for non-human use research; and
- Other members appointed at the discretion of the Senior Vice President for Administration.

Reports and recommendations of the Radiation Safety Committee are directed to the Associate Senior Vice President for Administrative Operations and the Senior Vice President for Administration for review and implementation.

Office of Environmental Health & Safety (EH&S)

The Radiation Safety Officer (RSO) and the Radiation Safety Staff of the Office of Environmental Health and Safety are responsible for managing and implementing the USC Radiation Safety Program. The RSO and the Radiation Safety Staff will conduct an annual review of the Radiation Safety Program and report findings to the RSC.

Radiation Safety Officer (RSO) and Staff

It is the responsibility of the Radiation Safety Officer to manage the Radiation Safety Program and ensure the compliance and safety of all staff working with radioactive materials and/or radiation-producing devices.

The RSO and the Radiation Safety Staff have the shared responsibility to:

- Assist in the development of general policies for control of radiation.
- Develop and distribute information relative to radiation protection.
- Implement an inspection program to ensure that laboratory facilities and procedures are in accordance with USC policies and California Radiation Control Regulations.
- Maintain and update an inventory of radioactive materials and radiation-producing devices.
- Evaluate:
  - Equipment and physical facilities; and
  - Operational techniques and procedures.
- Conduct:
  - Radiation risk assessments when required;
  - Training programs in radiation protection and safety;

- Testing programs for containment systems with radioactive material use (e.g. fume hoods, glove boxes);
- A contamination survey program in lab areas where radioactive materials are handled; and
- A bioassay program to monitor for internal deposition of radionuclides.

- Advise on:
  - Safe use of radioactive materials and radiation-producing devices; and
  - Decontamination of facilities and equipment following spills or prior to remodeling or modification of facilities.
- Respond to emergencies and investigate accidental exposures.
- Aid in the completion of applications for:
  - A permit to use radioactive materials or radiation-producing devices; and
  - Research protocols that involve the use of radioactive materials or radiation-producing devices on humans or animals.
- Manage dosimetry program and issue personnel dosimetry devices.
- Receive and inspect packages containing radioactive materials.
- Process outgoing shipments of radioactive materials in accordance with present federal and state regulations.
- Test sealed sources for leakage.
- Calibrate portable radiation survey instruments.

Radiation Users (RU)

User Definitions

Authorized User

Trained and experienced faculty members that are qualified to supervise the use of radioactive material at USC are designated by the Radiation Safety Committee as Authorized Users.

Non-Faculty Authorized Users

In some circumstances, doctorate-level individuals who are qualified by training and experience to use radioactive material, but are not members of the USC faculty (e.g., research fellows), may be designated Non-Faculty Authorized Users. These individuals may use radioactive material only in conjunction with a Faculty Authorized User who is willing to be accountable for the radioactive material and to ensure that all USC policies are followed.

Permit Holder

The Radiation Safety Committee is responsible for issuing Radiation Use Authorization (RUA) permits. Only one Authorized User is allowed to be designated on a RUA permit as the Permit Holder. In cases where two or more Authorized Users are using the same facility, only one permit will be issued for the facility with one of the Authorized Users designated as the RUA Permit Holder, and the others listed on the permit as Authorized Users.

Technical Staff

Individuals other than the Authorized User who work primarily under one permit for an extended period and routinely use radioactive materials (e.g., graduate students, postdoctoral fellows, laboratory technicians) will be designated as "Technical Staff."

The Authorized User must notify the Radiation Safety Program before technical staff members are permitted to work with radioactive material.

Technical Staff are authorized to use only specific radioactive materials and quantities as defined in the permit application once the required training is completed. See Section 5 Inspection Program and Training – Training Requirements).

Students

Students (e.g., Rotating students, Edmonson Fellow students, and Magnet High School students) may work with radioactive material under the guidance of an Authorized User. These students will not be considered "Technical Staff". The Authorized User must notify the Radiation Safety Staff before students are permitted to work with radioactive material.

Students are authorized to use only specific radioactive materials as defined in the permit application once the required training is completed. See Section 5 Inspection Program and Training – Training Requirements).

Students may only work with quantities less than 1 millicurie per procedure. If quantities defined in the permit application are less than 1 mCi, students will use the lesser amount. This will ensure that these individuals do not fall under dosimetry or bioassay requirements.

The Permit Holder is responsible for ensuring that these individuals' radioactive material usage is limited to these quantities.

Minors

Individuals under 18 years of age (minors) may be considered as either Technical Staff or Students (see requirements above). However, USC further restricts usage by minors to exempt level quantities authorized under the permit. Exempt level quantities are defined in 17 CCR 30235.

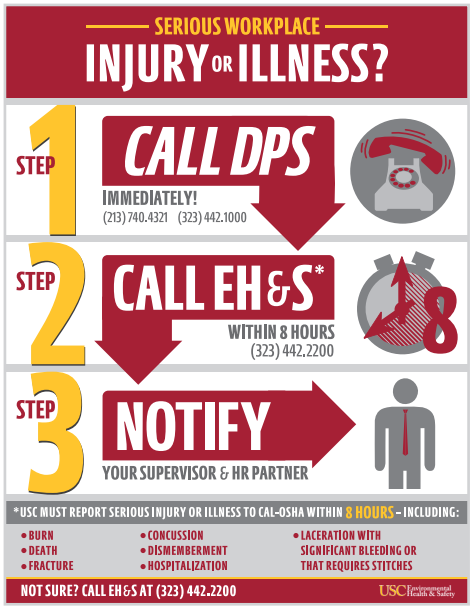
Authorized User Responsibilities

The Authorized User is directly responsible for all aspects of radiation safety associated with the possession and use of radioactive materials under his/her permit. Additionally, it is the responsibility of the Authorized User to:

- Comply with:
  - California Radiation Control Regulations;
  - Conditions of the USC Radioactive Materials License;
  - Conditions of the Radiation Use Authorization (RUA) permit; and
  - The USC Radiation Safety Manual and policies of the Radiation Safety Committee.
- Provide:
  - Instructions and training on safe and proper radiation practices to all persons working within the facilities of the Permit Holder. These rules must be prominently posted in the Authorized User's laboratory area(s) and all laboratory personnel must know where these procedures are posted;
  - Emergency procedures for laboratory personnel. These procedures must include the names and telephone numbers of key lab personnel (e.g., Principal Investigator, Lab Manager, and Safety Officer) to contact in case of emergency.

    These procedures shall be prominently posted in work areas where radioactive materials and radiation-producing devices are used (see Radiation Safety Emergency Procedures). Furthermore, USC's 1-2-3 Emergency Notification poster (Figure 3.1) should also be prominently posted in the laboratory;
  - Necessary equipment for safe work with radiation and radioactive material;

Figure 3.1. 1-2-3 Emergency Notification



Source: EH&S - http://tiny.cc/usc-123

  - Annual laboratory safety refresher training to all staff working with radioisotopes, radiation-producing devices and hazardous materials; and
  - Easy access to Safety Data Sheets (SDSs).
- Maintain adequate control of the radioactive material to ensure that areas beyond the Permit Holder's control are not adversely affected by its use.
- Properly label all radiation sources, areas, and equipment.
- Notify the Radiation Safety Program of any accident or abnormal incident involving or suspected of involving radiation and radioactive material.
- Inform the Radiation Safety Program:
  - Of any changes in personnel and any significant changes in lab design or procedures; and
  - In advance of plans to relocate the lab or leave the university.
- Ensure initial training of:
  - Hazardous materials users through USC's General Laboratory Safety Course; and
  - Radioisotope and/or radiation-producing equipment users through the applicable radiation safety training courses offered by EH&S at USC.
- Prepare Standard Operating Procedures (SOP) including Safe Work Practices for all routine processes involving hazardous materials conducted in the facility.
- Hold safety meetings regularly.
- Determine and document the personal protective equipment (PPE) needed for each procedure.

The **Technical Staff** and **Students** must follow the direction of the **Authorized User** to use radiation-producing devices and radioactive materials. Additionally, it is the responsibility of the Technical Staff and Students to:

- Comply with the requirements outlined in this Manual; the conditions of the permit; and all university safety policies;
- Know the emergency procedures;
- Work with radioactive material only after receiving initial laboratory safety and radiation safety training;
- Attend annual refresher training provided by Authorized User or designee;
- Attend Safety Meetings;
- Report any unsafe practices to the Permit Holder and the RSO or the Radiation Safety Program; and
- Notify the RSO or the Radiation Safety Program of any accident or incident involving or suspected of involving radioactive material or radiation-producing devices.

Authorized User Responsibilities During His/Her Absence

For an Absence Less than Four Weeks

Option 1: The Authorized User (AU) will ensure that the use of radioactive material will be under the supervision of a qualified Technical Staff member.

Option 2: The Authorized User will suspend the use of radioactive material and ensure its safe storage for the duration of the absence.

For an Absence of Four Weeks of More

Option 1: The Authorized User will suspend the use of radioactive material and ensure its safe storage for the duration of the absence.

Option 2: The Authorized User may submit to the Radiation Safety Program the name of another Authorized User ***who is willing to assume responsibility*** for safe use of radioactive material.

NOTE: This interim AU must be approved by the Radiation Safety Committee and must submit a signed statement of intent to the Radiation Safety Program, committing to the ***responsibilities of being the interim Authorized User*** for the lab.

Resignation of An Authorized User

In the event an Authorized User resigns his/her post, he/she must complete the following:

- Notify the Radiation Safety Program at least two weeks in advance of the departure;
- Complete all Radioactive Material Usage and Disposal Records for any radioactive materials used or disposed of;
- Contact the Radiation Safety Program to perform a closeout survey. This ensures that all equipment and facilities used with radioactive materials are free of radioactive contamination. NOTE: This includes equipment being shipped to a new location and/or equipment remaining at USC;
- Return any personal dosimetry devices issued to the Authorized User;
- Ensure proper disposal of all radioactive materials. If radioactive materials are not to be used again, discard them in appropriate disposal containers following routine disposal procedures. Arrange for pick-up by EH&S through EH&S website, EH&S Assistant online software, or by calling EH&S at 323-442-2200.
- Transfer radioactive materials to another USC Authorized User's permit per Section 5, "Procurement, Receipt & Transfer of Radioactive Materials".
- Make arrangements with the Radiation Safety Program to transfer radioactive materials to the Authorized User's new location; and
- Have a post-operational bioassay performed by the Radiation Safety Program if Authorized User participated in the bioassay program.

4.0 Radiation Use Authorization (RUA)

Radiation Use Authorization (RUA) Application

Trained and experienced faculty members that are qualified to supervise the use of radioactive materials at USC can be designated by the Radiation Safety Committee as Authorized Users. To become an Authorized User, a faculty member must submit an application to the Radiation Safety Committee via iStar* describing:

- Training and experience;
- Facilities;
- Radiation detection equipment;
- Types of work planned including:
  - radionuclides and amounts to be used; and/or
  - the radiation-producing machine to be used;
- Special safety devices;
- Procedures for control of radioactive material and radiation exposures;
- Emergency procedures; and
- Waste disposal methods

NOTE: See Section 10: Facilities, Equipment, and Registration for additional requirements specific to radiation-producing devices.

*The iStar system is a web-based application routing and tracking system that increases the efficiency of the approval and administrative processes for projects and protocols involving human subjects and animals in research. iStar is a collaborative effort between USC's Institutional Review Boards (IRBs), Institutional Animal Care and Use Committee (IACUC), Institutional Biosafety Committee (IBC), Radiation Safety Committees (RSC) and Children's Hospital Los Angeles (CHLA) to standardize and computerize research protocol application process.

Process for Submitting an RUA Application

1. Complete an application on iStar
2. Application will be reviewed by Radiation Safety Staff
3. Completed application will be submitted/presented to the RSC for review
4. Approvals will be issued based on the type of work that applicant is seeking authorization to do
5. Applicants approved to use radioactive materials will be contacted by Radiation Safety Specialists, who will conduct an initial radiation safety inspection to assist the new Authorized User with his/her lab set up

The permit will list the Permit Holder, the Authorized User(s), the radionuclides (or radiation-producing devices), the physical and/or chemical forms and the amounts authorized for use, authorized rooms, radiation survey equipment, and any special conditions imposed by the Radiation Safety Committee. Permits are valid for three years.

Amendments

Minor amendment requests to a permit include: addition/deletion of personnel and the addition/deletion of lab locations. Minor amendments may be requested by the Permit Holder/Authorized User by submitting an amendment application via iStar. The Radiation Safety Officer (or designee) approves minor amendment requests on an interim basis and subsequently presents the amendment requests to the RSC for a final vote and approval.

Major amendment requests include new procedures/protocols, new radioactive materials, increase in procedure limits, or a significant change in hazard level that require additional supporting documentation. Major changes in a permit will require approval of the Radiation Safety Committee. Major amendmendments may be requested by submitting an amendment application via iStar.

Radiation Use in Animals

Use of radioactive material or radiation-producing devices with animals must be authorized both by the Radiation Safety Committee and the Institutional Animal Care and Use Committee (IACUC).

Researchers must describe the following precautions and procedures to be used in the handling and care of animals as part of their iStar submission for the IACUC and RSC:

- Facilities for injecting radioactive material into live animals – Describe procedures for restraining animals during injection and the method for containing any radioactive material lost during injection. For example, when handling small animals, a tray lined with absorbent material is recommended;
- Radiation-producing devices used with animals – Describe the type of device, exposure doses, and procedures for handling animals;
- Labeling of cages for the injected animals – Cage labeling is especially important for animals that are not euthanized within a short period of time post injection; the label includes:
    - (a) the type of radionuclide,
    - (b) quantity of material injected per animal,
    - (c) date of injection, and
    - (d) the Authorized User.
- Type of cage used to contain the animals – Describe the type of cage that will be used. If contamination is likely to be a problem, a metabolic cage is recommended;
- Monitoring and decontaminating cages – Maintain records of radiation levels and wipe tests for all cages used to house radioactive animals;
- Segregation of the injected animals from other animals – Are long-term retention studies being conducted? This information is especially important for the protocol;
- Disposal of animal excreta – Describe the methods to be used for disposal;
- Ventilation – Engineering controls will be needed to contain an administered radioactive material if it is volatile by nature or excreted in volatile form. If it is excreted in the urine or feces, dust-free bedding must be used; and

- Training of animal handlers – Describe the training that the Authorized User will provide to animal handlers, including radiation dose levels, time limitations, and special handling requirements specified for the animals and/or their excreta.

NOTE: Arrangements must be made in advance with the Department of Animal Resources and the USC Radiation Safety Program for the housing of animals containing radioactive materials. Animal husbandry activities in the vivaria for animals containing radioactive materials are to be performed by the Permit Holder's staff.

Radiation Use in Humans

Use of radiation-producing devices and radioactive materials in research involving human subjects is overseen by USC's Office of Compliance on Human Subject Research, the Institutional Review Board (IRB), and RSC. Research protocols must be submitted to all three committees.

Application for Research

All applications for use of radiation in human subject research are submitted to the three aforementioned committees through the iStar system.

If a research protocol also includes use of a new radioactive drug(s) (or radiolabeled tracers) in a patient, then: (a) an additional application must be submitted to the Radioactive Drug Research Committee (RDRC) for review or (b) an Investigational New Drug (IND) application must be filed with the FDA. The RDRC reviews and approves the application as specified by the Food and Drug Administration's RDRC regulations 21 CFR 361.1. NOTE: RDRC is required to meet at least once a year and will convene additional meetings as needed.

An iStar application is required for radiation procedures beyond clinically indicated tests and/or therapy. A protocol submission to the RSC is not necessary if the radiation is used as part of a "Standard of Care" protocol for patients.

Review and Approval

It is incumbent upon researchers to submit all human-use research protocols that involve radiation to the Radiation Safety Program. The Radiation Safety Program previews the protocols for accuracy and completeness prior to RSC review and approval (see Figure 4.1). The RSC meets the second Thursday of every month. For more information, visit the RSC web page or contact the Radiation Safety Program at 323-442-2200 or radsafety@usc.edu.

Incomplete protocols will not be submitted for RSC review regardless of their time-sensitive nature.

NOTE: Protocol acceptance is subject to collective approval by the USC Research Compliance Office on Human Subject Research, IRB, and RSC.

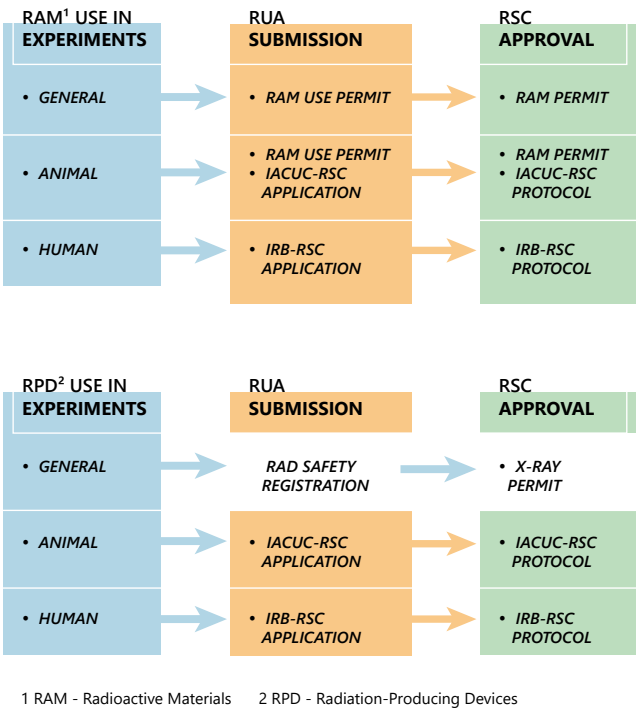
Renewal

Most human use approvals are valid for the length of the study unless otherwise specified.

Amendments

The Principal Investigator (PI) or study coordinator is responsible for informing the Radiation Safety Program of any major amendments to the protocol(s). All amendments are submitted via iStar.

Figure 4.1. RAM and RPD Approval Process



1 RAM - Radioactive Materials 2 RPD - Radiation-Producing Devices

RUA Permit Renewals

RUA permits are valid for three years and expire on the last day of the month indicated on the permit. The Radiation Safety Program will contact the Permit Holder prior to the expiration date to discuss the permit renewal. All information will be carefully reviewed to ensure that it accurately describes current conditions and is sufficient to meet current regulatory requirements. Permit renewal applications must be submitted through iStar.

If the permit is not to be renewed, the Permit Holder must inform the Radiation Safety Program of the intent to allow the permit to expire. Submission of a new application for a RUA permit is required for any permits that have expired.

The option to inactivate a permit is available for Permit Holders who do not have any future plans to use radioactive materials.

The usage of radioactive materials may be reinstated for inactivated permits without the submission of a new application.

Permit Holders who do not submit a request for renewal or do not respond to a request for additional information within the time limits will be asked to turn over their radioactive materials to the Office of Environmental Health and Safety for disposal. Permit Holders may submit a request for disposal of their radioactive materials at any time through Environmental Health & Safety Assistant (EHSA). EHSA is an on-line system that supports the management of the radiation safety program at USC. For complete instructions on how to submit a request for disposal of radioactive materials via EHSA, refer to the following Standard Operating Procedures (SOPs):

- EHSA SOP – RAM Inventory Management
- EHSA SOP Radioactive Waste Management

5.0 Inspection Program and Training

Inspection Program

The Radiation Safety Program ensures effective implementation of and compliance with: USC Radiation Safety Manual; USC safety policies; and, all regulatory requirements through:

- Inspection of all laboratories where radioactive materials are used;
- Periodic audits of Permit Holder activities;
- Follow-up on items of non-compliance;
- Tracking of training data to ensure all individuals working with RAM are trained;
- Tracking of doses received by radiation workers; and
- Updates of policies in response to changes in regulatory requirements.

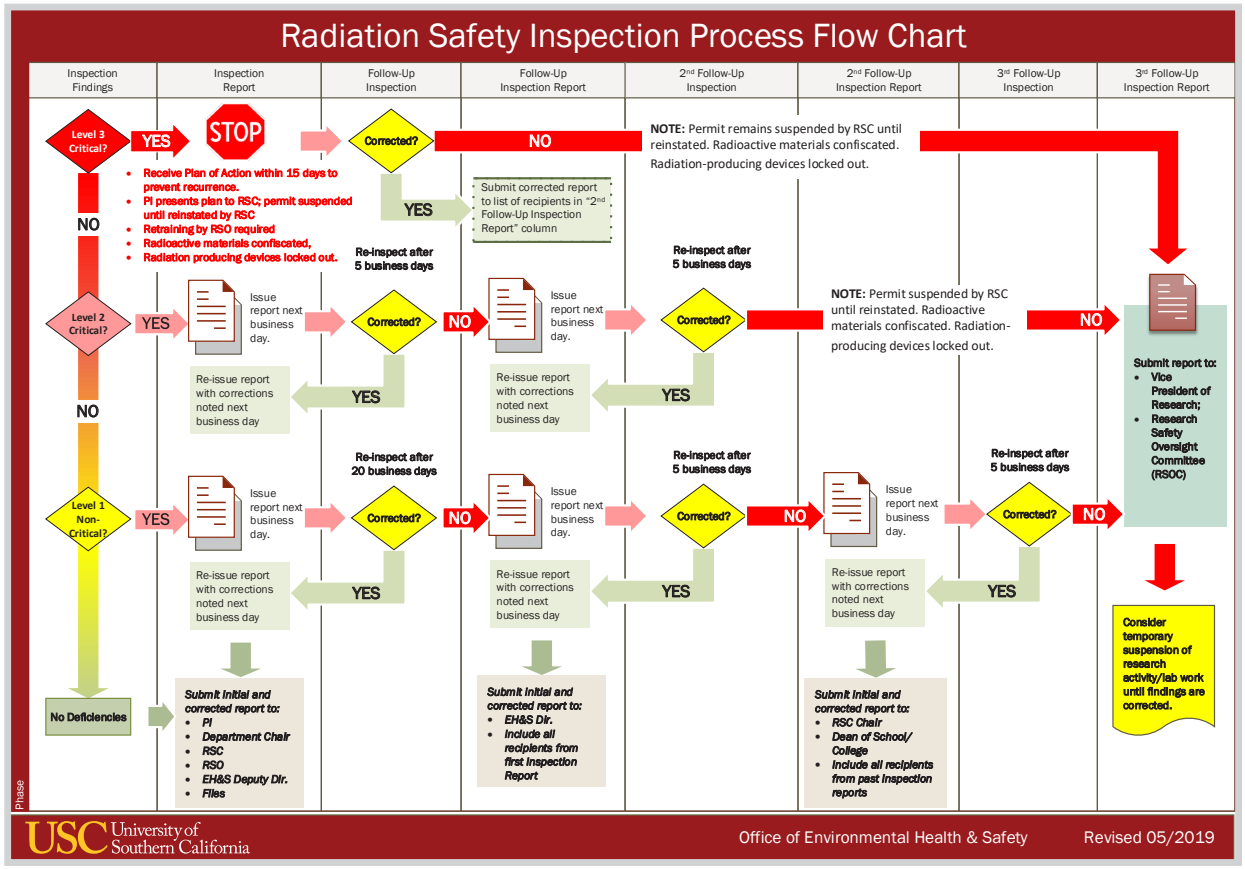
The Radiation Safety Officer reports inspection findings and doses exceeding ALARA levels received by USC workers to the Radiation Safety Committee. Issues of special concern are brought immediately to the attention of the Chair of the RSC; the Director, of EH&S; and others of note (see Figure 5.1). Inspections of RUA permits include the following:

- Presence of radioactive contamination
- Contamination Survey Record availability
- Inventory record availability
- Survey instrument calibration and availability
- Proper documentation of radiation safety training
- Appropriate Standard Operating Procedures for radioactive work taking place in laboratory
- Proper utilization of dosimetry, if issued
- Proper storage and handling of radioactive waste
- Security of radioactive materials
- Proper labeling of radioactive material work areas, equipment, and isotopes
- Authorized personnel working with radioactive materials
- Authorized rooms used for radioactive material work
- Adherence to food and drink policy, including the proper labeling of refrigerators, freezers, and microwaves
- Proper utilization of personal protective equipment (PPE)
- Availability of operating and emergency procedures, "Notice to Employees", and required records
- Certifications of fume hoods and biosafety cabinets where radioactive materials are used.

Inspections of radiation machine use permits include the following:

- Radiation Safety X-Ray Producing Devices Book
- Functionality of device indicators, interlocks, and emergency shut-off buttons
- Device labeling
- Authorized personnel working with radiation-producing equipment
- Proper documentation of radiation safety training
- Proper utilization of dosimetry, if issued
- Security of radiation-producing machines
- Authorized rooms used for radiation work
- Availability of the manufacturer's operating manual

Figure 5.1. Radiation Safety Inspection Process Flow Chart



Source: EH&S - http://tiny.cc/usc-rad-inspection-flow

- Maintenance of machine utilization log
- Posting of "Notice to Employees" and "Caution – X-Ray" warning signs
- Radiation exposure within acceptable limits
- Proper utilization of personal protective equipment

When items of non-compliance are discovered, the Radiation Safety Program will first determine the criticality of the finding (Levels 1 through 3; 3 equals Severe). For all criticality levels, the Permit Holder will be provided written notification of all findings within 24 hours of the inspection. In addition, the following actions will occur for levels 1 through 3:

Level 1 Findings (Non-Critical)

For Level 1 findings that were not corrected at the time of inspection, the permit will be re-inspected after 20 business days, with escalated actions and notifications for continued non-compliance (see Figure 5.1).

Level 2 Findings (Critical)

For Level 2 findings that were not corrected at the time of inspection, the permit will be re-inspected after 5 business days, with escalated actions and notifications for continued non-compliance (see Figure 5.1).

Level 3 Findings (Immediate Suspension)

For Level 3 findings, the permit is immediately suspended until reinstated by the Radiation Safety Committee. Radioactive materials will be confiscated and radiation-producing devices will be locked out. In order to reinstate the permit, the Permit Holder must submit a Plan of Action to prevent recurrence, within 15 days of the inspection, and then present the plan to the RSC at their next meeting. Additionally, the PI and staff will be re-trained in proper procedures by the RSO (see Figure 5.1 for more details).

When a Plan of Action is required for submittal to the Radiation Safety Committee, the Permit Holder will provide:

1. What caused the item(s) of non-compliance,
2. Actions taken to date by the Permit Holder to correct the item(s), and
3. Corrective actions the Permit Holder took or will take to prevent recurrence.

Regardless of the level of any inspection finding, chronic non-compliance could result in an administrative review by the RSC and may lead to cancellation of the permit. Where evaluation by the RSO indicates recurring or chronic problems, continued authorization of the permit by the RSC may be contingent upon a more frequent/extensive monitoring program and additional personnel training.

Training Requirements

All individuals who work with radioactive materials (see User Definitions in Section 3) or radiation- producing devices, or are in the vicinity of these hazards must be educated about the potential health hazards of ionizing radiation as well as methods and procedures to minimize exposure to radiation under the California Radiation Control Regulations (CRCR) and the USC Radiation Safety Program.

All individuals (including Faculty, Technical Staff and students) must complete the General Lab Safety course and initial Radiation Safety Training course PRIOR TO working with radioactive materials or radiation-producing machines. Successful completion of the courses is a prerequisite for working with radiation at the university.

Non-Human Use

Faculty members may be exempted from the initial Radiation Safety training course at USC provided they:

- Have documentation of equivalent training at another institution.
- Are able to successfully pass USC's initial Radiation Safety Training Quiz.
- Have practical experience with the types and quantities of radioactive materials they intend to use.

Human Use

Physicians who wish to use radioactive materials for medical purposes or to conduct human use research, must comply with the acceptable training and experience guidelines in 10 CFR 35 as incorporated by reference in Section 30195 (a) of the California Radiation Control Regulations.

The California Department of Public Health (CDPH) requires Certified Radiologic Technologists (CRT) to be supervised by physicians with valid Supervisor and Operator Permits issued by CDPH for any use of X-rays on humans (whether clinical or research).

In general, this applies only to uses where the occupational dose is unlikely to exceed 500 mrem per year (one-tenth the annual limit for occupational exposure). The Radiation Safety Officer may require special instruction for limited use applicants.

Limited Use

Select (limited) users (e.g., electron microscopes, analytical x-ray units, irradiators) may receive approval based on demonstration of knowledge of the radiation hazards and regulations associated with the particular use requested.

Additional Training

- ***Device-Specific Training***: For all users who will be using X-ray producing devices for research (see X-ray Safety Manual).
- ***X-ray Irradiator Training***: For users who will be using X-ray irradiator training. Contact radsafety@usc.edu to schedule a training.

Annual In-Service Training

The Authorized User is required to provide annual in-service training to all individuals. This training must be documented and sent to USC Office of Environmental Health & Safety every year.

Annual in-service training will include:

- A review of:
  - Laboratory safety procedures;
  - Proper use of protective equipment (e.g., syringe shields, lead aprons, and remote handling devices);
  - Personal protective equipment; and
  - Emergency procedures for fire, earthquake, and accidental spill or other accidents involving radioactive material or radiation-producing devices.
- Changes in the permit;
- Special radiation safety problems;
- Items of noncompliance found during inspections;
- Recordkeeping; and
- Other topics provided by the Radiation Safety Program.

The Radiation Safety Program will provide guidelines for the design of in-service training programs (e.g., Annual Lab Safety Refresher Training) if requested.

Documentation

All radiation safety-related training or education that employees receive must be documented and maintained on file for review by the Radiation Safety Program.

6.0 Procurement, Receipt, and Transfer of Radioactive Materials

Procurement

Radioactive Materials must be ordered through USC eMarket (see Figure 6.1, Radioactive Material Purchase Fact Sheet). The use of credit cards or P-cards to order radioactive materials is not allowed. General information on USC eMarket is available at USC eMarket Login and Information.

When access to USC eMarket is granted, order radioactive materials as follows:

1. Select forms under Shop/Search box then "Non-Catalog (Goods)" from Forms tab.

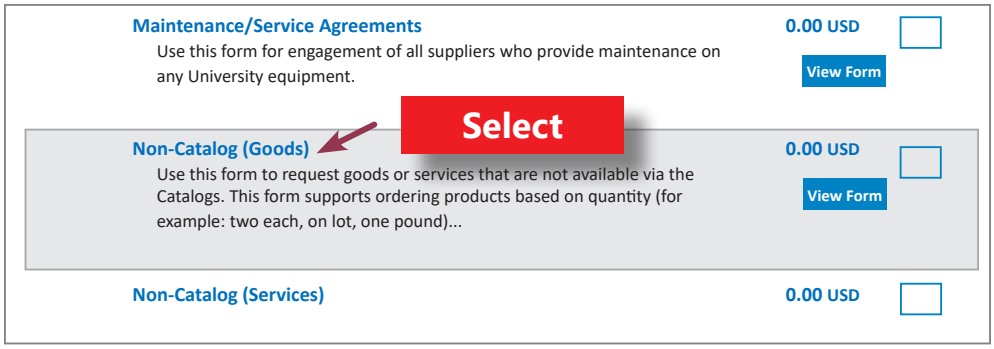
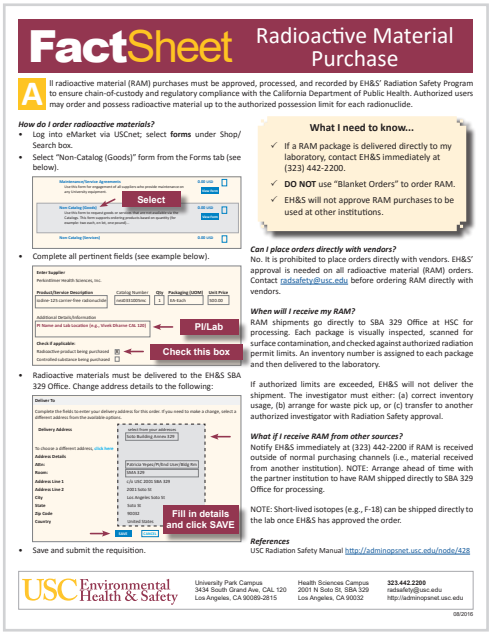
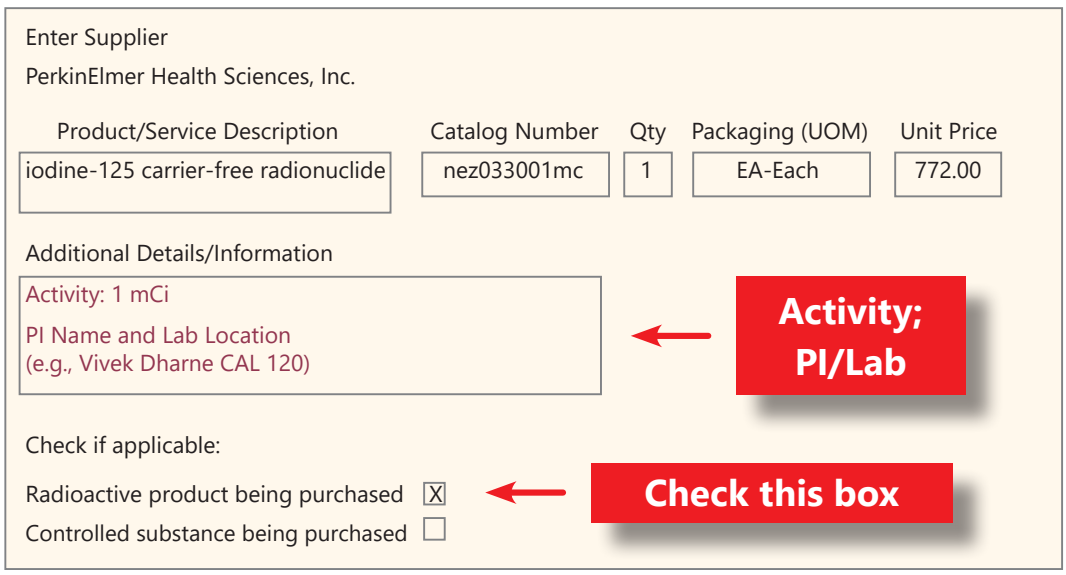


Figure 6.1. Radioactive Material Purchase

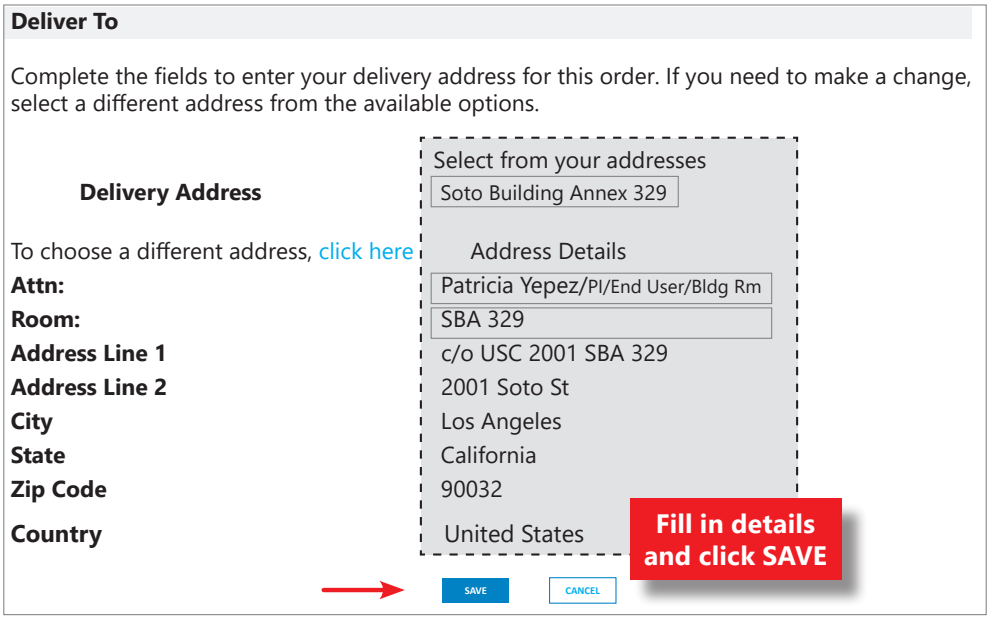


http://tiny.cc/usc-ehs-RAM-buy

2. Complete all pertinent fields. Check the box next to "Radioactive product being purchased".
3. Radioactive materials must be delivered to the EH&S SBA 329 Office.



4. Save and submit the requisition.



The Radiation Safety Program will review the requisition before it is finalized and will approve only if the following conditions are met:

- The end user is authorized to use the material on a valid RUA permit;
- There are no outstanding compliance issues for the RUA permit e.g., missing radiation safety training records;
- The amount ordered does not increase inventory beyond the possession limits stated on the permit; and
- The address for delivery is: 2001 N. Soto Street, SBA 329, Los Angeles, CA 90032.

Non-Standard Order and Receipt of Radioactive Materials

Authorized Laboratories that have been approved by the Radiation Safety Office are authorized to order and receive short lived PET Tracers directly from outside vendors. All other locations for direct delivery must be approved by the Radiation Safety Committee prior to ordering.

Receipt of Radioactive Packages

Radioactive packages are first received by the Office of Environmental Health and Safety for inspection and processing prior to distribution to the end user. Radiation Safety Staff will:

1. Check the package(s) for damage, excessive exposure rate, contamination or when required by regulation.
2. Enter receipt of package into EHSA. EHSA assigns a radioactive inventory number to each source container.
3. Place the radioactive inventory number on each final source container;
4. Generate a Receipt Log for each inventory number assigned;
5. Notify the Authorized User that the shipment has arrived;
6. Provide a copy of the Packing Slip with the Receipt Log and package(s);
7. Deliver the package to the lab; and
8. Deface the Radioactive Material labels on shipping containers as appropriate before disposal.
9. Remind laboratory personnel that they must completely deface the Radioactive Material labels on shipping containers as appropriate before disposal.

The Authorized User or his/her representative must: (a) verify the type and quantity of radioactive material ordered, (b) sign the Receipt Log, and (c) take receipt of packing slip when delivered to the lab.

Direct Delivery to Lab

Labs are not authorized to receive radiation package directly from vendors. If a package is directly delivered to lab by the vendor, please inform Radiation Safety immediately. Radiation Safety will document the details from the package and assign it an inventory number. Radiation Safety will approve labs for direct receipts of short-lived isotopes (e.g., F-18) from vendors. A written Standard Operating Procedure (SOP) will be given to the lab to follow. The SOP will include a receipt log sheet for all incoming packages that will indicate receipt date, received activity, surface and 1 meter readings (mR/hr), survey instrument used, contamination survey (if required), etc.

The laboratory is required to keep records of receipt of packages. Radiation Safety will periodically review to ensure that all necessary information is being collected and retained.

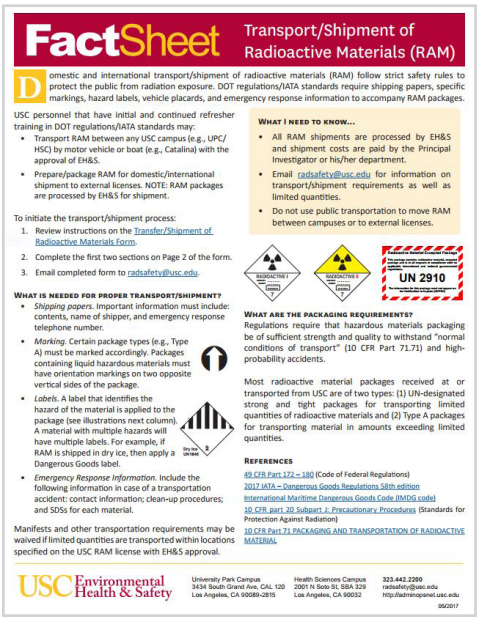
Radioactive Material Usage Record

The Authorized User or Technical Staff must log each usage of radioactive materials in EHS Assistant (EHSA). The EHSA SOP: Radioactive Material Inventory Management shows instructions for how to update usage records.

Transfer of Radioactive Material

Do not transfer radioactive material, either on campus or to another institution, without prior approval by the Radiation Safety Program (see Figure 6.2, Transport/Shipment of Radioactive Materials (RAM) Fact Sheet). If Radioactive Materials are inadvertently delivered to another location, notify the Radiation Safety Program **immediately** by calling **323-442-2200**.

Figure 6.2. Transfer/Shipment of Radioactive Materials



FactSheet

Transport/Shipment of Radioactive Materials (RAM)

Domestic and international transport/shipment of radioactive materials (RAM) follow strict safety rules to protect the public from radiation exposure. DOT regulations/IATA standards require shipping papers, specific markings, hazard labels, vehicle placards, and emergency response information to accompany RAM packages.

USC personnel that have initial and continued refresher training in DOT regulations/IATA standards may:

- Transport RAM between any USC campus (e.g., UPC/HSC) by motor vehicle or boat (e.g., Catalina) with the approval of EH&S.
- Prepare/package RAM for domestic/international shipment to external licenses. NOTE: RAM packages are processed by EH&S for shipment.

To initiate the transport/shipment process:

1. Review instructions on the Transfer/Shipment of Radioactive Materials Form.
2. Complete the first two sections on Page 2 of the form.
3. Email completed form to radsafety@usc.edu.

WHAT IS NEEDED FOR PROPER TRANSPORT/SHIPMENT?

- *Shipping papers.* Important information must include: contents, name of shipper, and emergency response telephone number.
- *Marking.* Certain package types (e.g., Type A) must be marked accordingly. Packages containing liquid hazardous materials must have orientation markings on two opposite vertical sides of the package.
- *Labels.* A label that identifies the hazard of the material is applied to the package (see illustrations next column). A material with multiple hazards will have multiple labels. For example, if RAM is shipped in dry ice, then apply a Dangerous Goods label.
- *Emergency Response Information.* Include the following information in case of a transportation accident: contact information; clean-up procedures; and SDSs for each material.

Manifests and other transportation requirements may be waived if limited quantities are transported within locations specified on the USC RAM license with EH&S approval.

WHAT I NEED TO KNOW...

- All RAM shipments are processed by EH&S and shipment costs are paid by the Principal Investigator or his/her department.
- Email radsafety@usc.edu for information on transport/shipment requirements as well as limited quantities.
- Do not use public transportation to move RAM between campuses or to external licenses.

RADIOACTIVE I

RADIOACTIVE II

UN 2910

WHAT ARE THE PACKAGING REQUIREMENTS?

Regulations require that hazardous materials packaging be of sufficient strength and quality to withstand "normal conditions of transport" (10 CFR Part 71.71) and high-probability accidents.

Most radioactive material packages received at or transported from USC are of two types: (1) UN-designated strong and tight packages for transporting limited quantities of radioactive materials and (2) Type A packages for transporting material in amounts exceeding limited quantities.

REFERENCES

49 CFR Part 172 – 180 (Code of Federal Regulations)
2017 IATA – Dangerous Goods Regulations 58th edition
International Maritime Dangerous Goods Code (IMDG code)
10 CFR part 20 Subpart J: Precautionary Procedures (Standards for Protection Against Radiation)
10 CFR Part 71 PACKAGING AND TRANSPORTATION OF RADIOACTIVE MATERIAL

USC Environmental Health & Safety

University Park Campus
3434 South Grand Ave, CAL 120
Los Angeles, CA 90089-2815

Health Sciences Campus
2001 N Soto St, SBA 329
Los Angeles, CA 90032

323.442.2200
radsafety@usc.edu
http://adminopsnet.usc.edu

05/2017

http://tiny.cc/usc-ehs-RAM-xprt

Transfer to Another USC Permit

To transfer radioactive material from one USC RUA permit to another, the Authorized User must complete and submit the Transfer/Shipment of Radioactive Materials Form to the Radiation Safety Program for review and approval. A record of each transfer must be kept in the Radioactive Material Usage Record. Radiation Safety will assist with documentation for the transfer.

Transfer or Shipment to Another License

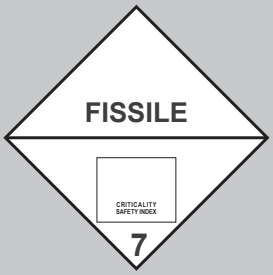
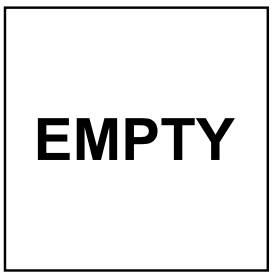
Before shipment or transfer of radioactive material to another licensee (e.g., LAC/USC Medical Center or other academic institutions) can take place, the Authorized User must provide a current copy of the receiver's radioactive materials license to the Radiation Safety Program.

The Authorized User is responsible for furnishing the necessary packing materials and labels for transfer/shipment of the radioactive material (see Table 6.1. Labels Used on Radioactive Materials Packages). The Radiation Safety Program will provide information concerning acceptable packages and packing materials on request.

Transfer/shipment of radioactive materials on the USC campus will be performed by the Radiation Safety Program during normal working hours. Special arrangements may be made if transfer/shipment during normal working hours is impossible.

Records of each transfer/shipment will be maintained by the Radiation Safety Program. The Authorized User is also required to maintain records of the transfer and to adjust the inventory records accordingly.

Table 6.1. Labels Used on Radioactive Materials Packages

Label	Label Information	Example*
Radioactive White-I	Extremely low radiation levels 0.5 mrem/hr (0.005 mSv/hr) maximum on surface	
Radioactive Yellow-II	Low radiation levels > 0.5 - 50 mrem/hr (0.5 mSv/hr) maximum on surface; 1.0 mrem/hr (0.01 mSv/hr) maximum at 1 meter	
Radioactive Yellow-III	Higher radiation levels > 50 - 200 mrem/hr (2 mSv/hr) maximum on surface; 10 mrem/hr (0.1 mSv/hr) maximum at 1 meter ***Also required for HRCO shipments, regardless of radiation level***	
Fissile	Applied to packages that contain fissile materials. The Criticality Safety Index (CSI) for each package will be noted on the label. When used, the fissile label will appear adjacent to the radioactive material label.	
Empty	Applied to packages that have been emptied of their contents as far as practical, but may still contain regulated amounts of internal contamination and minimal radiation levels detectable outside the package (< 0.5 mrem/hr).	

* Standard size is 4 inches x 4 inches

Generally Licensed Radioactive Material

Figure 6.3. Generally Licensed Radioactive Material and Devices Information

Generally Licensed Radioactive Material is low activity radioactive material that is contained in certain commercial products or devices. These products or devices are distributed by licensed facilities to individuals or institutions who are not required to be licensed in order to possess the material.

	GLD	Exempt Qty RAM	Source Material[1]
Description	Generally Licensed Devices (GLD) include the following: • Liquid scintillation counters with internal calibration sources (Cs-137, Ba-133, Eu-152, Ra-226) • Static eliminators (Po-210) • Smoke detectors (Am-241) • Self-illuminating exit signs (H-3) • Some gas chromatographs (Ni-63) 	Exempt quantities of RAM (radioactive material) are small sources containing small amounts of radioactivity, such as button sources used for teaching and check sources used for instrument calibration. 	"Source Material" refers to the elements uranium (not enriched in the isotope U-235) and thorium (including any of their physical or chemical forms) ores that contain less than 0.05% of these elements, and depleted uranium (DU). 
Registration	• Register Generally Licensed Devices with EH&S (required by regulatory agencies for broad scope radioactive material licensees, such as USC). • Exceptions: **Exit signs and smoke detectors**.	• Register Exempted Quantities RAM sources with EH&S (required by regulatory agencies for broad scope radioactive material licensees, such as USC).	• Registration with EH&S is **NOT** required for Source Materials • Source Materials are bought and used as a chemical; refer to the Chemical Hygiene Plan for guidance.
Inventory	• Keep updated inventories of GLDs. • Notify EH&S of any relocation, modification, or intended disposal of devices. • Store in a locked lab	• Keep updated inventories of RAM sources. • Notify EH&S of disposal of RAM. • Store in a locked lab.	• Keep updated inventories of source materials as part of the Chemical Inventory section in EHSA. • Record depletions of stock and transfers to chemical waste.
Safe Handling	• **DO NOT** disassemble devices at any time to avoid exposure. • Devices that contain lead shielding may be adversely affected if moved/relocated. Contact manufacturer for information or assistance.	• Avoid cutting, drilling, or exposure to high temperatures or pressures to maintain source integrity.	• Handle source materials as chemicals; refer to the Chemical Hygiene Plan for guidance. Routes of exposure are: inhalation, ingestion, or injection/broken skin. • Most applications using source materials pose minimal external radiological hazards.
Radioactive Contamination	If leakage or damage to the radioactive source is suspected, remove the equipment from operation and contact Radiation Safety immediately.	If leakage or damage to the radioactive source is suspected, remove the source from use and contact Radiation Safety immediately.	Clean spilled source material using paper towels and simple cleaning solutions, e.g., degreasers. Dispose of materials from spill cleanup as radioactive waste.
Hazardous Waste Management	Contact Radiation Safety for disposal (radsafety@usc.edu). Do not remove or tamper with equipment or the source inside the GLD.	Request a rad waste pick-up via EHSA. See EHSA SOP Radioactive Waste Management for details.	• Request a chemical waste pick-up via EHSA. See EHSA SOP Waste Pickup + Supplies for details. • **DO NOT** mix Source Materials with other chemical waste for disposal.

[1] Source Materials present an internal radiation exposure hazard if they are inadvertently inhaled, ingested, injected, or enter the body through broken skin. Wear proper PPE prior to working with Source Material. Refer to the Chemical Hygiene Plan for guidance. Contact DPS (213) 740-4321 and Radiation Safety (323) 442-2200 immediately if a source material spill poses an intake risk (e.g., volatile material, personnel contamination, or large area/volume spill) or is outside the registered lab.

7.0 Good Laboratory Practices

The following general laboratory practices apply to all personnel who use radioactive material and will be incorporated into each laboratory's written procedures (see Radioactive Material Handling Fact Sheet).

Signs and Notices

All areas where radioactive materials are used or stored will have the "Notice to Employees" (See Figure 7.1) and "Radiation Emergency Procedures" signs (See Figure 7.2) displayed in conspicuous locations.

Figure 7.1. Notice to Employees

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH

NOTICE TO EMPLOYEES

STANDARDS FOR PROTECTION AGAINST RADIATION

CALIFORNIA RADIATION CONTROL REGULATIONS (CALIFORNIA CODE OF REGULATIONS, TITLE 17, SECTION 30255)

The California Radiation Control Regulations include standards for protection against radiation hazards. The California Department of Public Health has primary responsibility for administering these standards which apply to both employers and employees. Enforcement is carried out by the California Department of Public Health or its authorized inspection agencies.

EMPLOYEES' RESPONSIBILITIES

You should know and understand those California radiation protection standards and your employer's operating and emergency procedures which apply to your work. You should comply with these requirements for your own safety and the safety of others. Report promptly to your employer any condition which may lead to or cause a violation of these standards or employer's operating and emergency procedures.

SCOPE OF THE STANDARDS

The Standards for Protection Against Radiation define:

1. Limits on exposure to radiation and radioactive materials;
2. Actions to be taken after accidental exposure;
3. Working conditions requiring personnel monitoring, safety surveys, engineered controls, and safety equipment;
4. Proper use of caution signs, labels, and safety interlock devices;
5. Requirements for keeping worker exposure records and reporting of such exposures;
6. The requirement for specific operating and emergency procedures for radiation work; and
7. The rights of workers regarding safety inspections.

EMPLOYERS' RESPONSIBILITIES

Your employer is required to:

1. Comply with the requirements of the California Radiation Control Regulations, departmental orders, and license conditions;
2. Post or make available to you copies of the Radiation Control Regulations, any license issued thereunder, and your operating and emergency procedures;
3. Post any notice of violation of radiological working conditions; and
4. Provide you with information on your exposure to radiation.

REPORTS ON YOUR RADIATION EXPOSURE HISTORY

1. California Radiation Control Regulations require your employer to give you a written report if you receive an exposure greater than the limits set in the radiation safety standards. Basic limits for occupational radiation exposure can be found in section 30253 referencing title 10, Code of Federal Regulations, part 20 (10 CFR 20). Limits on exposure to radiation and exposure to concentrations of radioactive material in air are specified in 10 CFR 20, subpart C.
2. If the radiation protection standard, under 10 CFR 20 (subpart F) requires that your radiation exposure be monitored, your employer must, upon your request, give you a written report of your exposures upon termination of your employment, and make available to you the information in your dose records (as maintained under the provisions of 10 CFR 20.2108).
3. Your employer is required to provide you with an annual report of the dose you received in that monitoring year if the dose exceeds 100 millirem, or if you request an annual report.

INSPECTIONS

The Department or one of its contractors will inspect your workplace from time to time to ensure that health and safety requirements are being followed and that these requirements are effective in protecting you. Inspectors may confer privately with you at the time of inspection. At that time you may direct the inspector's attention to any condition you believe is or was a violation of the safety requirements.

In addition, if you believe at any time that any health and safety requirements are being violated, you or your workers' representative may request that an inspection be made by sending a complaint to the Department of Public Health or other official agency. Your complaint must describe the specific circumstances of the apparent violation and must be signed by you or your workers' representative. The Department is required to give your employer a copy of any such complaint. Names may be withheld at your request. You should understand, however, that the law protects you from being discharged or discriminated against in any way for filing a complaint or otherwise exercising your rights under the California Radiation Control Regulations.

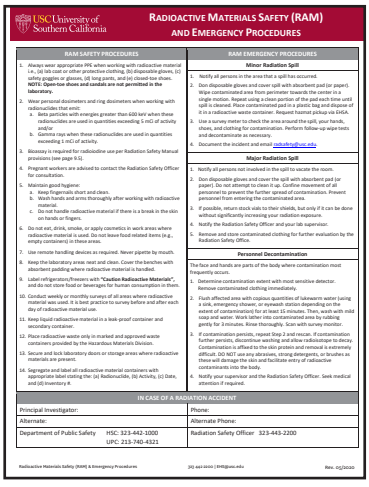
POSTING REQUIREMENTS

Copies of this notice must be posted in a sufficient number of places in every establishment where employees are employed in activities regulated by the California Radiation Control Regulations, to permit employees working in or frequenting any portion of a restricted area to observe a copy on the way to or from their place of employment.

FOR RADIOLOGICAL EMERGENCY ASSISTANCE (24/7), PHONE 1-800-852-7550
To contact the Radiologic Health Branch, phone (916) 327-5106
or go to the Radiologic Health Branch (https://www.cdph.ca.gov/rhb)

RH 2366 (04/17)

Figure 7.2. Radiation Emergency Procedures



USC University of Southern California

RADIOACTIVE MATERIALS SAFETY (RAM) AND EMERGENCY PROCEDURES

RAM SAFETY PROCEDURES

1. Always wear appropriate PPE when working with radioactive material i.e., (a) lab coat or other protective clothing, (b) disposable gloves, (c) safety goggles or glasses, (d) long pants, and (e) closed-toe shoes. **NOTE: Open-toe shoes and sandals are not permitted in the laboratory.**
2. Wear personal dosimeters and ring dosimeters when working with radionuclides that emit:
   a. Beta particles with energies greater than 600 keV when these radionuclides are used in quantities exceeding 5 mCi of activity and/or
   b. Gamma rays when these radionuclides are used in quantities exceeding 1 mCi of activity.
3. Bioassay is required for radioiodine use per Radiation Safety Manual provisions (see page 9-5).
4. Pregnant workers are advised to contact the Radiation Safety Officer for consultation.
5. Maintain good hygiene:
   a. Keep fingernails short and clean.
   b. Wash hands and arms thoroughly after working with radioactive material.
   c. Do not handle radioactive material if there is a break in the skin on hands or fingers.
6. Do not eat, drink, smoke, or apply cosmetics in work areas where radioactive material is used. Do not leave food-related items (e.g., empty containers) in these areas.
7. Use remote handling devices as required. Never pipette by mouth.
8. Keep the laboratory areas neat and clean. Cover the benches with absorbent padding where radioactive material is handled.
9. Label refrigerators/freezers with **"Caution Radioactive Materials"**, and do not store food or beverages for human consumption in them.
10. Conduct weekly or monthly surveys of all areas where radioactive material was used. It is best practice to survey before and after each day of radioactive material use.
11. Keep liquid radioactive material in a leak-proof container and secondary container.
12. Place radioactive waste only in marked and approved waste containers provided by the Hazardous Materials Division.
13. Secure and lock laboratory doors or storage areas where radioactive materials are present.
14. Segregate and label all radioactive material containers with appropriate label stating the: (a) Radionuclide, (b) Activity, (c) Date, and (d) Inventory #.

RAM EMERGENCY PROCEDURES

Minor Radiation Spill

1. Notify all persons in the area that a spill has occurred.
2. Don disposable gloves and cover spill with absorbent pad (or paper). Wipe contaminated area from perimeter towards the center in a single motion. Repeat using a clean portion of the pad each time until spill is cleaned. Place contaminated pad in a plastic bag and dispose of it in a radioactive waste container. Request hazmat pickup via EHSA.
3. Use a survey meter to check the area around the spill, your hands, shoes, and clothing for contamination. Perform follow-up wipe tests and decontaminate as necessary.
4. Document the incident and email zakurkhe@usc.edu

Major Radiation Spill

1. Notify all persons not involved in the spill to vacate the room.
2. Don disposable gloves and cover the spill with absorbent pad (or paper). Do not attempt to clean it up. Confine movement of all personnel to prevent the further spread of contamination. Prevent personnel from entering the contaminated area.
3. If possible, return stock vials to their shields, but only if it can be done without significantly increasing your radiation exposure.
4. Notify the Radiation Safety Officer and your lab supervisor.
5. Remove and store contaminated clothing for further evaluation by the Radiation Safety Office.

Personnel Decontamination

The face and hands are parts of the body where contamination most frequently occurs.

1. Determine contamination extent with most sensitive detector. Remove contaminated clothing immediately.
2. Flush affected area with copious quantities of lukewarm water (using a sink, emergency shower, or eyewash station depending on the extent of contamination) for at least 15 minutes. Then, wash with mild soap and water. Work lather into contaminated area by rubbing gently for 3 minutes. Rinse thoroughly. Scan with survey monitor.
3. If contamination persists, repeat Step 2 and rescan. If contamination further persists, discontinue washing and allow radioisotope to decay. Contamination is affixed to the skin protein and removal is extremely difficult. DO NOT use any abrasives, strong detergents, or brushes as these will damage the skin and facilitate entry of radioactive contaminants into the body.
4. Notify your supervisor and the Radiation Safety Officer. Seek medical attention if required.

IN CASE OF A RADIATION ACCIDENT

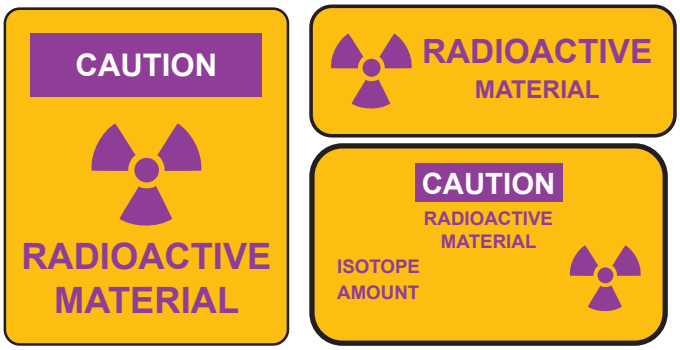
Principal Investigator:	Phone:
Alternate:	Alternate Phone:
Department of Public Safety HSC: 323-442-1000 UPC: 213-740-4321	Radiation Safety Officer 323-443-2200

Radioactive Materials Safety (RAM) & Emergency Procedures — 323.442.1000 | EHS@usc.edu — Rev. 03/2020

The following areas or equipment shall be clearly marked with signs, notices, or labels that bear the standard radiation symbol and "CAUTION RADIOACTIVE MATERIAL" verbiage (See Figure 7.3).

- All doors to laboratories, rooms, and storage areas where radioactive materials are used or stored;
- Fume hoods, refrigerators and freezers where radioactive material is used or stored; and
- Contaminated equipment.

Figure 7.3. Radioactive Material Labels



Source: Biodex

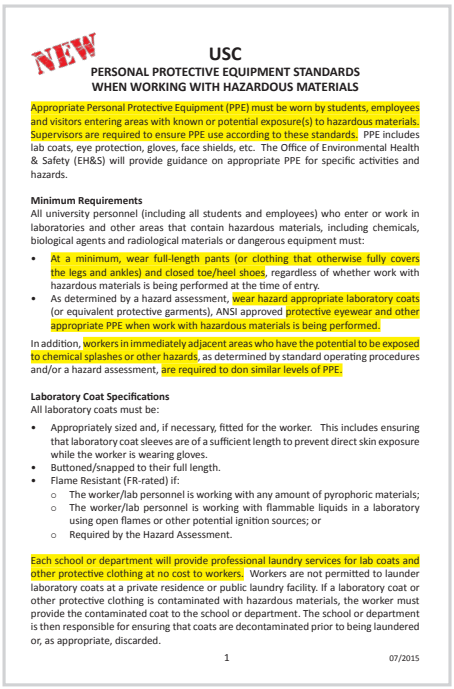
All containers that store or transport radioactive material must bear labels with the: (a) radionuclide; (b) amount of activity in mCi; (c) date of assay; (d) standard radiation symbol. **NOTE:** This does not apply to small quantities that are in sample containers for less than one day. The Radiation Safety Program may approve exceptions to the above guidelines, but only in accordance with CRCR.

Personal Protective Equipment (PPE) and Laboratory Hygiene

USC has a Personal Protective Equipment (PPE) policy in place when working with hazardous materials. (See Figure 7.4). All university personnel (including all students and employees) who enter or work in laboratories and other areas that contain hazardous materials, including chemicals, biological agents and radiological materials or dangerous equipment must at a minimum, wear full-length pants (or clothing that otherwise fully covers the legs and ankles) and closed toe/heel shoes.

1. Wear personal whole body and finger ring dosimeters as required and issued by the Radiation Safety Program.
2. Personal protective equipment (PPE) for working in university laboratories is determined by completion of the Lab Hazard Assessment Tool (LHAT). Additionally, wear long pants, loose long-sleeved shirt, and non-permeable, closed-toe shoes.
3. When working around unshielded radiation-producing devices, it is recommended that you wear lead aprons and thyroid collars. It is also recommended that all protective aprons or gloves be inspected for radiation leakage at least every six months, or whenever the integrity of the equipment is suspect.
4. Maintain good personal hygiene by:
   - Keeping fingernails short and clean;
   - Washing hands and arms thoroughly before handling any object that goes into the mouth, nose, or eyes; and
   - Not handling radioactive material if there is a break in the skin below the wrist;
5. Wear two layers of disposable gloves when handling radioactive material and change frequently;
6. Keep the laboratory neat and clean; and

Figure 7.4. USC Personal Protective Equipment Standards



NEW

USC
PERSONAL PROTECTIVE EQUIPMENT STANDARDS WHEN WORKING WITH HAZARDOUS MATERIALS

Appropriate Personal Protective Equipment (PPE) must be worn by students, employees and visitors entering areas with known or potential exposure(s) to hazardous materials. Supervisors are required to ensure PPE use according to these standards. PPE includes lab coats, eye protection, gloves, face shields, etc. The Office of Environmental Health & Safety (EH&S) will provide guidance on appropriate PPE for specific activities and hazards.

Minimum Requirements
All university personnel (including all students and employees) who enter or work in laboratories and other areas that contain hazardous materials, including chemicals, biological agents and radiological materials or dangerous equipment must:

- At a minimum, wear full-length pants (or clothing that otherwise fully covers the legs and ankles) and closed toe/heel shoes, regardless of whether work with hazardous materials is being performed at the time of entry.
- As determined by a hazard assessment, wear hazard appropriate laboratory coats (or equivalent protective garments), ANSI approved protective eyewear and other appropriate PPE when work with hazardous materials is being performed.

In addition, workers in immediately adjacent areas who have the potential to be exposed to chemical splashes or other hazards, as determined by standard operating procedures and/or a hazard assessment, are required to don similar levels of PPE.

Laboratory Coat Specifications
All laboratory coats must be:

- Appropriately sized and, if necessary, fitted for the worker. This includes ensuring that laboratory coat sleeves are of a sufficient length to prevent direct skin exposure while the worker is wearing gloves.
- Buttoned/snapped to their full length.
- Flame Resistant (FR-rated) if:
  - The worker/lab personnel is working with any amount of pyrophoric materials;
  - The worker/lab personnel is working with flammable liquids in a laboratory using open flames or other potential ignition sources; or
  - Required by the Hazard Assessment.

Each school or department will provide professional laundry services for lab coats and other protective clothing at no cost to workers. Workers are not permitted to launder laboratory coats at a private residence or public laundry facility. If a laboratory coat or other protective clothing is contaminated with hazardous materials, the worker must provide the contaminated coat to the school or department. The school or department is then responsible for ensuring that coats are decontaminated prior to being laundered or, as appropriate, discarded.

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7. Do not smoke, eat, drink, or apply cosmetics in the laboratory.
8. Do not wear contact lenses in the lab.

Questions? Contact the Radiation Safety Program at 323-442-2200 or radsafety@usc.edu.

Storage

- Label refrigerators, freezers, storage areas, containers, etc. per Section 7, "Signs and Notices". Refrigerators and freezers will also have a "No Food or Drink" label;
- Keep radioactive material in a leak-proof container; and
- Secure and lock laboratory doors or storage areas when materials are left unattended.

Handling

- Wear disposable gloves when handling sealed or unsealed containers of radioactive material. Use remote handling devices if required by the Radiation Safety Program.
- Never pipette by mouth.
- Use absorbent padding in areas where radioactive material is handled.
- Perform iodinations or work that involves volatile radioactive material only in a fume hood specifically approved by the Radiation Safety Program. Contact the Radiation Safety Program if approved fume hood is not available.

Surveys

Surveys for Radiation Producing Devices

Radiation-producing devices must be surveyed by Radiation Safety Staff for dose-rate prior to the initial operation and whenever any change is made in the installation that might change the radiation level to which a person could be exposed. In evaluating the results of the survey, the actual operating conditions, including workload, use factor, occupancy, and attenuation of the useful beam by patients or objects, must be the criteria for recommendations of changes.

A written record of all such surveys must be submitted to the Radiation Safety Program within one week, unless the survey indicates abnormal values, in which case the Radiation Safety Program must be informed immediately.

Surveys for Radioactive Materials

It is highly recommended that surveys be performed both during work and after each use of unsealed radioactive materials. In addition, laboratories are responsible for documenting periodic surveys (use the Monthly Contamination Check Form) in all spaces listed on the PI's RUA. Survey results are then entered into EHSA (see EHSA SOP Contamination Surveys - PI). The lab must keep the survey records available for review for three years. The RSO may require more frequent surveys if contamination has increased to levels that could pose an exposure problem or cause regulatory concern. This will be determined upon review of the lab's survey records.

For labs using tritium (H-3), a wipe survey analyzed by liquid scintillation counter is required to satisfy the survey requirements. NOTE: Tritium is not detectable with standard portable radiation survey instruments.

A wipe survey and or an instrument survey must be completed for other isotopes as well. If a laboratory has no radioactive material use in a given month, no surveys need to be documented for that month. In lieu of the monthly survey, the lab must note on the survey form or online that "*No radioactive material was used*".

As per USC's licensing requirement, the Radiation Safety Program/EH&S performs confirmation surveys in all labs on a quarterly basis as part of the lab audit program. Quarterly surveys are also performed in:

- Common lab spaces used by more than one principal investigator, but not listed on any one Authorized User's RUA permit; and
- Common areas such as the vivarium, the Core Facility in a building, or a shared freezer farm.

If a lab is slated for removal from a permit, the lab staff is required to conduct a complete survey of the lab. The Radiation Safety Program will then follow-up with a confirmation survey.

Contamination Survey Frequencies

Radioactive contamination surveys are conducted and documented periodically by users as defined in Table 7.1. The survey frequency will depend on the Hazard Class (HC) as calculated by the RSO per USC's Radiation License.

Table 7.1. Survey Frequency

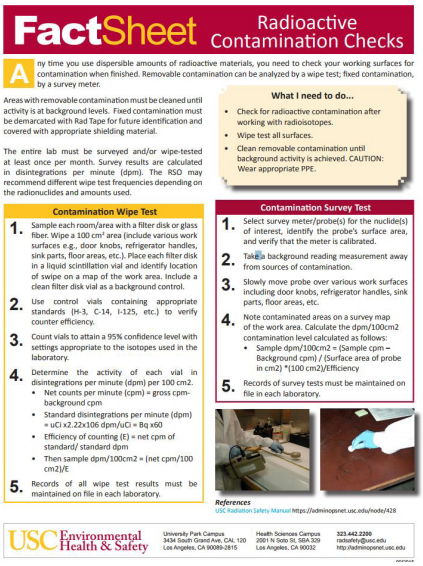
Use	Frequency
< 10% ALI	Quarterly
Hazard Class < 1	Monthly
1 ≤ Hazard Class ≤ 100	Weekly
Hazard Class > 100	Daily

The RSO may require more frequent surveys if a chronic contamination pattern is observed. Facilities (such as patient rooms) or equipment (such as animal cages) must be surveyed for contamination prior to release. **NOTE: Departments of Nuclear Medicine and PET will conduct daily surveys whenever isotopes are used.**

Survey Methods

See Figure 7.5 Radioactive Contamination Checks Fact Sheet.

Figure 7.5. Radioactive Contamination Checks



http://tiny.cc/usc-ehs-radchk

Direct Surveys

Labs with appropriate portable survey instruments may perform direct contamination surveys (See Figure 7.6) to assess surface contamination. Wipe tests must be used to distinguish between fixed and removable contamination.

Figure 7.6. Direct Survey

Indirect Surveys

Conduct wipes tests (See Figure 7.7) in all areas where radioactive materials are used when:

- Appropriate portable survey instruments are not available
- Assessing removable contamination
- Low energy beta emitters are being handled (e.g., 3H)

Figure 7.7. Indirect Survey

Survey Procedures

Record the numerical results of a survey on a map/form of the area. Include the background for exposure/contamination and mark the location of any exposure/contamination that exceeds the background level. Survey all the following areas (when present):

- Bench tops in areas where radioactive material is used or stored. If covered with absorbent paper, wipe under the paper if possible.
- Floors by areas where radioactive material is used/stored and where the radioactive waste container is located. Also, floors near entrances or exits to the location (high traffic areas).
- Sinks (drain, faucet handles, etc.).
- Fume hoods. If an experiment is in progress, survey the front edges of the hood and/or the handles of the sliding window.
- Lab equipment marked for use with radioactive material including freezers and refrigerators. Concentrate on the areas where the individual's hands touch during use (e.g., handles and control knobs) or other areas as appropriate.
- Telephone handles, doorknobs, and personnel desks as appropriate.

Using Survey Instruments

The purpose of survey instruments is to reveal the presence of unsuspected, loose, or fixed contamination and measure general area radiation levels to ensure they are close to or at background levels.

A survey instrument is required for monitoring radioactivity whenever the usage (not possession limit) of radioactive materials meets the criteria shown in Table 7.2.

Table 7.2. Requirements for Radiation Survey Instruments

Radionuclide	Requirement
Any gamma emitter	Portable survey meter/Gamma Counter
Any beta emitter with max energies > 600 keV	Portable survey meter/Liquid Scintillation Counter (LSC)
Any soft beta emitter with max energies < 600 keV	Liquid Scintillation Counter (LSC)

Instrument Calibration

Portable radiation survey instruments are calibrated annually by the Radiation Safety Program. If calibration service is overdue for a survey instrument, notify radsafety@usc.edu. Labs are responsible for all costs related to the maintenance and calibration services of liquid scintillation counters and gamma counters. It is highly recommended that labs purchase a service contract with these instruments. The Radiation Safety Staff can helps labs identify calibration service providers.

Instrument Selection

Survey instruments will be purchased by the Permit Holder and will be based on the criteria outlined in Section 10, Radiation Detection Instruments. **NOTE: Use instruments in modes for which they are calibrated. For instance, if an instrument is pulse calibrated, then use the count rate (cpm) scale.** Nuclide-specific instruments are recommended for research groups that are working with a sole radionuclide.

Contamination Surveys Using G-M Survey Meters

For grossly contaminated areas, follow the procedure below using a thin-window G-M Survey meter.

1. Confirm that the survey meter is calibrated. If not, contact Radiation Safety. Do not use a meter that is out of calibration.
2. Turn the survey meter on, check the battery status, and check for proper operation (e.g., the detector is able register background radiation).
3. Ensure that the survey meter and probe are free of contamination. If decontamination is needed, clean in an area where no known contamination or RAM exist.
4. Survey work areas and surfaces where contamination might spread (e.g., door knobs) regardless of whether radioactive materials were used.
5. ***For known Low-background Radiation Areas***: Place the probe so that the "window" is parallel to within 1 cm of the contaminated surface and move very slowly across it. ***For known High-background Radiation Areas***: Take wipe tests of selected areas and count by holding the wipes within 1 cm of the window in a low-background area. If the instrument reading is more than twice the background, contamination is present;
6. Decontaminate the area and perform follow-up wipe tests until the contamination is removed;
7. After performing wipe tests, re-scan these areas with the survey instrument.

Significant meter readings after decontaminating the area and negative wipe tests may indicate fixed contamination that is not easily removed. Contact the Radiation Safety Program for assistance at 323-442-2200 or radsafety@usc.edu.

Contamination Surveys Using Wipe Test

1. Wear two layers of disposable gloves and shoe covers (if floor contamination is suspected).
2. A minimum of five wipes will be taken to include:
    - All locations identified (e.g., benchtop, floor, sink, and fume hoods) for scanning by portable survey instruments.
    - Locations identified as contaminated by direct scan.
    - Random locations if necessary (do not exceed a total of 10 wipes).
3. Using filter paper, cotton swabs, or other suitable wipe medium, wipe an area of 100 cm^2 of a large surface. Wipe an entire surface only if a small object is being tested. NOTE: For routine wipe surveys, it is acceptable to wipe a much larger area and then wipe smaller areas if contamination is found.
4. Label the wipes or the counting vials and survey map for identification of the area wiped.
5. Count the wipes for gamma or beta radiation at one minute each. If the same wipe is counted for both gamma and beta radiation, then conduct the gamma count first before adding the liquid scintillation cocktail for the beta analysis.
6. Convert counts per minute (cpm) to uCi or dpm i.e., dpm = (cpm – bkg)/efficiency.
7. Record the information and retain it for three years.

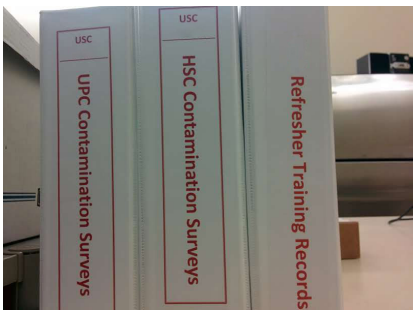
Contamination Action Levels

If wipes indicate more than 200 dpm/100 cm^2, the area wiped is considered contaminated. Decontaminate the "hot" area and repeat aforementioned survey procedures. Continue this cycle until wipes indicate less than 200 dpm/100 cm^2. If unable to reduce contamination to below 200 dpm/100 cm^2, contact the Radiation Safety Program for assistance and further instruction at 323-442-2200 or radsafety@usc.edu.

Recordkeeping

The following records must be maintained by the Permit Holders:

- In-service training of laboratory personnel (3 years)
- Radioactive Material Usage Records (3 years from date of final disposal of material)
- Radioactive Waste Disposal Forms (3 years)
- Wipe tests and Instrument surveys (3 years)
- Transfer Records (3 years)
- Calibration of dose calibrators and radiation detection instruments (3 years)
- The most recent permit application, the approved permit, and all correspondence relating to that permit



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8.0 Radioactive Waste Management and Disposal

Radioactive Waste Management

Radioactive waste is one of the major waste streams from university operations (e.g., research labs, medical clinics, and construction.) Strict regulations govern radioactive waste management and its disposal, and failure to comply may result in fines from the State and/or termination of the university's radioactive materials license.

Each Authorized User is responsible for ensuring that all his/her radioactive waste material is disposed of properly.

Release to Sanitary Sewage – IS NOT ALLOWED at USC

Contact Radiation Safety at (323) 442-2200 or radsafety@usc.edu for any questions regarding this restriction.

Administration to a Patient

According to the CRCR, once radioactive material is administered to a patient, no further account of its disposal is required.

WHAT I NEED TO KNOW

Segregation by Waste Categories

All radioactive materials that are not administered to a patient must be segregated in the laboratory by waste categories listed in Table 8.1.

Segregation by Radioisotope

Dedicate one container to one type of isotope waste. **DO NOT** mix isotopes. **NOTE**: If a mixture of isotopes is needed for an experiment contact Radiation Safety to come up with a hazardous waste disposal plan.

DECAY-IN-STORAGE (DIS) PROGRAM

With advanced approval by EH&S, laboratories working with extremely short-lived radioisotopes (e.g., F-18, C-11, N-13, O-15, Cu-64 and Zr-89) may decay their radioactive waste in storage with the proviso that they:

- Keep an accurate inventory of the waste placed in the DIS.
- Follow established procedures for the DIS of radioactive waste.
- Keep radioactive waste records for at least three years.

For additional information, contact Radiation Safety at (323) 442-2200 or radsafety@usc.edu.

Waste Containers

Containers will be replaced as required per scheduled pick-up. If additional (not replacement) containers are needed, contact the Radiation Safety Program for further instruction at 323-442-2200 or radsafety@usc.edu.

Each waste container should be clearly labeled with the radionuclide and have an adhesive radiation warning label attached. This includes sharps containers.

How do I dispose of radioactive material?

Document, Label, and Request Waste Pick-Up

All documentation for waste prepared for disposal is completed in EHS Assistant (EHSA), USC's web-based permit tracking system. Waste forms can be generated from the usage log, printed, and then attached to the waste containers.

1. Log into **EHSA** using your USC NetID (NOTE: All RAM Permit Holders and radiation workers can log into EHSA).
2. Click on the ***Inventory*** icon at the bottom of the page.
3. At the ***RAM Inventory*** box, click on "View In-Lab Waste Containers".
4. Follow detailed instructions in EHSA SOP Radioactive Waste Management to add containers for pickup, document results of contamination checks, and print waste forms.
5. Print two copies of the waste forms; one to keep and one to attach to the container.

NOTE: Improperly segregated radioactive waste and/or incomplete/invalid documentation will not be accepted for disposal.

Equipment Repair, Removal, or Disposal

Notify the Radiation Safety Program prior to the repair, removal, or disposal of any equipment that contains a radiation source or may be contaminated with radioactive material. The source and/or the contamination will need to be removed by the Radiation Safety Program. Additionally, notify the Radiation Safety Program prior to the removal or disposal of any radiation-producing machine (e.g. x-ray, electron microscope, etc.) so that registration with CDPH may be updated.

Radioactive Waste Disposal

Radioactive waste is one of the major waste streams from university operations (e.g., research labs, medical clinics, and construction). Strict regulations govern radioactive material and radioactive waste management. Failure to comply may result in fines from the state and/or termination of the university's radioactive material license.

Segregate radioactive waste into the following categories: Solids, Aqueous Liquid; Organic Liquid; Scintillation Vials Containing Unabsorbed Liquid, Sharps, Pathological Waste (e.g., animal carcasses), and Lead Pigs. Further segregate the radioactive waste according to radioisotope. Each radioisotope will have its own container.

EH&S provides all radioactive waste containers on campus. Each container illustrated on Page 2 is designated for a specific category of waste. **ALERT: DO NOT USE red biohazard bags for disposal.**

Solids

1. Collect solid waste into the appropriate waste containers. One isotope, one container.
2. **DO NOT** mix solid waste with liquid waste.
3. Ensure that each container has an adhesive radiation waste label attached.

Aqueous and Organic Liquids

1. **DO NOT MIX AQUEOUS** radioactive liquid waste with **ORGANIC** radioactive liquid waste.
2. Decant each radioisotope liquid waste into its own EH&S-provided liquid container.
3. Cap liquid container tightly after each use.
4. Mark the Date and Radionuclide on each bottle.
5. Place the liquid container in a secondary container to prevent accidental spills or leakage.

Vials Containing Unabsorbed Liquids

- Place vials with scintillation cocktails in drum. **DO NOT** include other solid waste with the vials.

Sharps

1. Fill sharps container to the Capacity Line. **DO NOT** exceed the line.
2. Close cap when full.
3. Label sharps container with an adhesive sticker that reads "Radioactive Material".

What I need to do

- Only use EH&S-provided containers for radioactive waste disposal. One isotope, one container.
- Wear appropriate personal protective equipment when handling radioactive waste.
- Questions? Contact radsafety@usc.edu.

Pathological Waste

- Place frozen animal carcasses and tissue samples in brown paper bags and keep in freezer until waste pick-up is arranged. The freezer is considered a container for EHSA records.

Lead Pigs

- Segregate from regular radioactive waste for special pick up.

Update Inventory/Request Waste PIckup via EHSA

1. Log into the EHSA online inventory to update waste container content information.
2. Seal the container(s), perform a contamination survey, and record contamination survey results.
3. Print two (2) copies of the EHSA waste report. Keep one for lab records; attach the other to the waste container.
4. Follow instructions in the EHSA SOP: Radioactive Waste Management document.
5. Once rad waste container/content is picked up, create a new container number for new waste container in EHSA.

Remember:

- DO NOT commingle dry waste with vials.
- DO NOT fill liquid containers completely. Leave enough head space to allow for expansion.
- DO NOT mix aqueous with organic liquid rad waste.
- DO NOT exceed the "fill line" of sharps containers.
- DO NOT pour radioactive liquids down the sink for disposal.

Reference

US NRC Title 10 Part 20 - Standards for Protection Against Radiation

CONTAINERS FOR RADIOACTIVE WASTE DISPOSAL

All radioactive waste must be segregated according to the following categories. NOTE: Different isotopes cannot be mixed in the same container. To arrange for rad waste pickup, follow instructions in the EHSA SOP: Radioactive Waste Management document.

HSC	UPC

Solids

- Petri dishes
- Glass tubes
- Plastic pipette tips
- Plastic pipettes
- Culture vials
- Plastic Vacutainer tubes
- Gauze, paper towels, plastic-backed absorbents or bench coat, etc.
- Contaminated gloves and other personal protective equipment.
- Waste from cages where animals injected/infused with radionuclides are housed.

Aqueous and Organic Liquids

- Liquids must be in non-breakable and compatible containers provided by EH&S.

Vials Containing Unabsorbed Liquids

- Liquid scintillation cocktail in vials only. DO NOT dispose of dry material in container.

Regulated Vials (RV)	De-Regulated Vials (DRV)
P-32; Si-32; P-33; S-35; Cl-36; Cr-51; I-125	C-14; H-3

Sharps

- Needles
- Razor blades, scalpels
- Microscope slides
- Glass pipettes
- Any contaminated material that can puncture/penetrate the skin or Red Bag.

Pathologicals

- Keep frozen animal carcasses or tissues from animals injected/infused with radionuclides prior to sacrifice.
- Place carcasses/pathological tissues in brown paper bags; **DO NOT** use sealable plastic bags. Keep in freezer until ready for pickup.

Lead Pigs

- Segregate from regular radioactive waste for special pick up.

The DOs and DON'Ts of RADIOACTIVE WASTE MANAGEMENT

- **DO** contact EH&S for radioactive waste management advice and supplies, including waste containers.
- **DO** keep waste containers capped when not actively being used.
- **DO** cap all liquid waste containers tightly after each use.
- **DO** place all liquid waste containers in a secondary container to prevent any accidental spill or leakage.

- **DO NOT** dispose of ANY LIQUID WASTE, including liquid scintillation cocktail (LSC) through the sanitary sewage system.
- **DO NOT** mix Aqueous Liquid Waste with Organic Liquid Waste.
- **DO NOT** fill liquid waste containers completely. Leave enough head space to allow for expansion.
- **DO NOT** exceed the "fill line" of sharps containers.
- **DO NOT** use biohazardous red bags for radioactive waste disposal.

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9.0 Personnel Dosimetry and Bioassays

Limits of Exposure to Ionizing Radiation

The occupational radiation dose limits are specified by the Federal Regulations (10 CFR 20.1201, 10 CFR 20.1207 and 10 CFR 20.1208) and are highlighted in Table 9.1. For occupational workers who are minors, there is an additional constraint which limits the annual dose to only 10 percent of the dose allowed for adults.

Table 9.1. Annual Dose Limits

Dose Term	Dose Limit
Whole Body	5 rem/yr
Lens of Eye	15 rem/yr
Skin, organ, or extremities	50 rem/yr
Minors	10% of the above specified limits for adult workers
Embryo/fetus of a Declared Pregnant Woman	0.5 rem/entire pregnancy*

*avoid substantial variation above a uniform monthly exposure rate of 0.05 rem/month during the entire pregnancy

Pregnancy

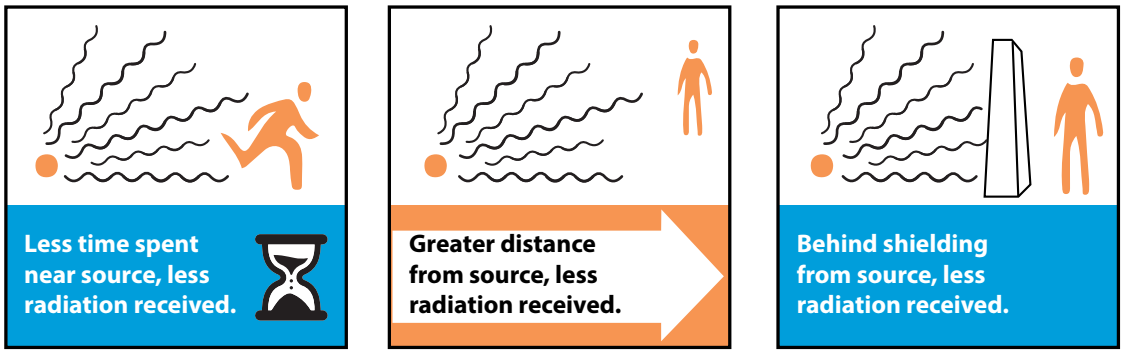
A Declared Pregnant Worker (DPW) is a woman who has voluntarily informed her immediate supervisor in writing of her pregnancy. For an employee who becomes pregnant, she can choose whether she wishes to declare her pregnancy. She may undeclare her pregnancy at any time. She can refer to Regulatory Guide 8.13 "Instruction Concerning Prenatal Radiation Exposure", published by the Nuclear Regulatory Commission (NRC), for a detailed discussion to inform her decision. She may also confidentially discuss her pregnancy with the Radiation Safety Officer if she has further questions after she consults the Regulatory Guide. If she decides to declare her pregnancy, she may do so by using the "Form Letter for Declaring Pregnancy". (A copy of the form letter may be obtained from the Radiation Safety Program at 323-442-2200 or radsafety@usc.edu).

Only once a worker has declared her pregnancy, the radiation exposure to the embryo/fetus is limited to 0.5 rem during the entire pregnancy while also avoiding substantial variations above a uniform monthly exposure rate. If she chooses to declare her pregnancy, she will be issued a dosimeter to monitor your fetal dose.

ALARA

Prevention (or mitigation) of radiation exposure to individuals well below the annual limits is espoused in the ALARA principle i.e., *As Low As Reasonably Achievable*. ALARA reduces risk through use of small quantities of radioactive materials, low radiation dose rates, and optimized engineering controls.

- ALARA is the effective use of Time, Distance, and Shielding to mitigate or eliminate exposure (see illustration below).
- TIME: Plan experiments to minimize time spent around radiation.
- DISTANCE: Maximize the distance of radiation exposure when working with radioactive sources and/or isotopes.
- SHIELDING: Use shielding to effectively reduce radiation exposure when working in close proximity to radiation sources and/or isotopes.



Source: NRC

Personnel Monitoring and Dosimetry

Personnel likely to receive a dose in excess of ten percent (10%) of the annual limit for occupational workers must wear a personal monitoring device (see Personnel Monitoring Devices - Radiation Fact Sheet). The RSC mandates that personal monitoring devices will be worn at USC by anyone who works with or works in the vicinity of:

- Open beam X-ray producing devices with the exception of dental x-ray machines
- PET Isotopes including locations such as the PET Center, Cyclotron and associated hot lab, and other research laboratories on campus
- Radioactive material in the Cyclotron and associated hot lab
- Radionuclides that emit beta particles with energies greater than 600 keV when these radionuclides are used in quantities exceeding 5 mCi of activity
- Radionuclides that emit gamma rays when these radionuclides are used in quantities exceeding 1 mCi of activity

Additionally, monitoring devices are needed for those who must enter a posted high radiation area and nursing staff caring for radiation therapy patients or working in the vicinity of radiation-producing devices that are not self-shielded. The RSO will make the final determination whether personal monitoring is required. The RSO may remove the requirement if dosimetry records indicate only minimal exposure over a period of at least one year.

Dosimeter Request Form

A Personal Dosimetry Add/Delete Form must be completed and signed by the individual requesting dosimetry. Special use requests will be evaluated by the Radiation Safety Program and approved if device issuance is warranted.

Dosimetry Monitoring Devices

The sole purpose of dosimetry monitoring devices (See Figures 9.1 and 9.2) is to record radiation exposure. They do not shield the wearer from the hazardous effects of radiation. Two types of personal dosimeters are routinely used at USC: Whole Body and Extremity (finger ring). Dosimeters are exchanged every month or every quarter as assigned.

Figure 9.1. Ring Dosimeter

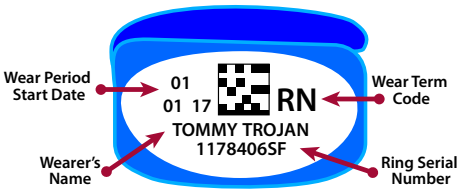
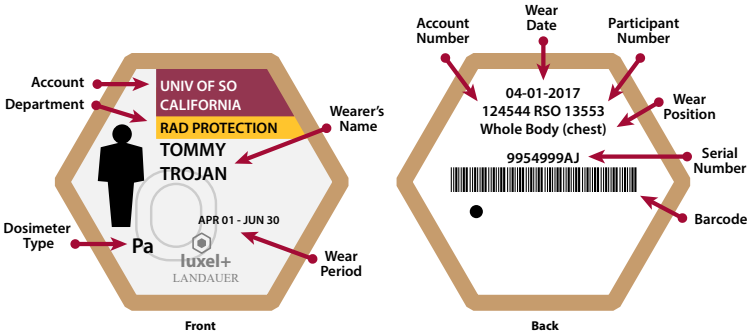


Figure 9.2. Dosimetry Badge



All dosimeters are commercially processed and the exposure reports are sent to the Radiation Safety Program for review. Any exposure that exceeds Investigation Level I (see Table 9.2), will be reviewed by the RSO who will report the results at the next RSC meeting. No further specific action is required unless deemed appropriate by the RSC. Monthly badges are issued to declared pregnant users and are terminated at the end of the gestational period. Any exposures above Level II (see Table 9.2) will be investigated by the RSO who will take appropriate action if warranted. Appropriate actions taken will include steps to prevent recurrence. Any individual may receive a copy of his/her exposure history by requesting it in writing from the Radiation Safety Program.

Table 9.2. Investigation Levels

Body Part	Level I	Level II
Whole Body, Head and Trunk, Active Blood-Forming Organs, Lens of the Eye, or Gonads	125 mrem/quarter	375 mrem/quarter
Hands and Forearms, Feet and Ankles	1,875 mrem/quarter	5625 mrem/quarter
Skin of Whole Body	750 mrem/quarter	2,250 mrem/quarter

Note that investigation levels are not new dose limits but serve as checkpoints above which the results are considered sufficiently important to justify investigations.

Proper Use and Care of Dosimeters

- Dosimeters are worn between the waist and the collar with the name showing and must be worn at all times while on duty (see Figure 9.3). If a lead apron is worn, the badge will be worn at the collar outside the apron. NOTE: Individuals who wear an apron, thyroid shield, and eye shield of at least 0.25 mm lead equivalent (0.5 mm for individuals working around fluoroscopic machines lacking lead drapes) may submit a written request for a variance to wear their badge under their apron.
- Leave the dosimeter in a safe place when not on duty. Make sure it is away from all sources of radiation. **DO NOT** take personal dosimeters off campus unless the Radiation Safety Program is notified.
- Never wear a dosimeter issued to another person or share your dosimeter with anyone else.
- Wear ring dosimeter with label facing radiation source (see Figure 9.4). **REMEMBER**: Wear glove over ring dosimeter before radiation work begins.
- Remove dosimeters from lab coats/aprons prior to sending to a professional laundry service.
- Return dosimeter at the proper time to exchange for a new one.
- Do not tamper with the dosimeter.
- A replacement must be obtained from the Radiation Safety Program immediately if the dosimeter is lost or damaged. Obtain and complete a "Radiation Exposure Investigation Form" from the Radiation Safety Program. Exposure is assessed for the time period lost and added to the wearer's personal exposure history.
- **Report any accidental exposure incident to the Radiation Safety Program immediately.**
- **DO NOT** wear the dosimeter if one is undergoing any medical procedure that involves radiation or radioactive material.
- For pregnant users working in radiation labs, wear badge on belly.

Figure 9.3. USC Badge Dosimeter

Source: EH&S

Figure 9.4. USC Ring Dosimeter

Source: EH&S

NOTE: *Wear glove OVER ring dosimeter prior to beginning work.*

Return of Dosimeters

Return personal dosimeters to the Radiation Safety Program by the fifth working day of the new wear period. Users that do not return dosimeters will receive a "Radiation Exposure Investigation Form" and will be instructed to return either the completed form or the dosimeter by the fourteenth working day of the month/quarter.

Consequences for Radionuclide users – If either the dosimeter or the form is not returned by the fourteenth working day, the Radiation Safety Program will not approve purchases or receive radioactive materials for the permit until the dosimeter or form is returned.

Consequences for Radiation-producing machine users – If either the dosimeter or the form is not returned by the fourteenth working day, the Radiation Safety Program will notify the user's Department Chair that the user is not permitted to operate radiation-producing equipment until the dosimeter or form is returned. Exemptions will be granted on an individual basis for individuals on vacation, sick leave, etc.

Bioassay Guidelines for Working with I-125 and I-131

The labeling of compounds with radioactive iodine (iodination) is a volatile process that can create exposure through inhalation. Radioiodine concentrates in and damages the thyroid of an exposed individual. All individuals who use unsealed radioiodine (such as I-125 and I-131) in quantities exceeding those listed in Table 9.3 will participate in this bioassay program to monitor radioiodine intake and subsequent radiation dose to the thyroid. The quantities in the table apply to that amount used in a single day. NOTE: This program is designed to meet the State of California Department of Health Services requirements for bioassay of I-125 and I-131.

Table 9.3. Radioiodine (I-125 & I-131) Requirements for Bioassay

Body Part	Level I	Level II
	Volatile/Dispersible	Non-volatile
Processes in open room or bench with possible escape of iodine from reaction vessel.	0.1 mCi	1 mCi
Processes with possible escape of iodine, carried out within a fume hood of adequate design, face velocity, and performance reliability.	1 mCi	10 mCi
Processes carried out within glove boxes, ordinarily closed, but with possible release of iodine or with occasional exposure to contaminated box and/or box leakage	10 mCi	100 mCi

Authorized Users are responsible for supplying the Radiation Safety Program the names of those individuals who meet the criteria for inclusion in the bioassay program. Authorized Users will not permit anyone who meets any of the criteria to work with radioiodine until they have undergone a baseline bioassay.

Additional Notes

- Individuals using 10 mCi or more of radioiodine per month will require a bioassay even if the quantities used at any one time are less than those described above.
- The Radiation Safety Program will determine bioassay requirements for unique procedures/equipment.
- The term "use" means removal of the radioactive material from the primary container and introduction into research procedures or other chemical processes.
- The frequency in which a bioassay is given is dependent on: the activity of radioiodine used; an action level being exceeded; and gross accidental exposure (see Table 9.4).

Investigation Level

An investigation level is reached when thyroid uptake exceeds: 0.1 µCi (Level I) or 0.3 µCi (Level II).

Investigation Level Protocol

The following steps will be taken whenever the above Investigation Levels are exceeded:

Level I:

- The individual will be notified of the dose.
- The RSO will report the dose to the Radiation Safety Committee (RSC). The RSC will compare the dose with others performing similar tasks as an index of ALARA program quality and will record the review in the Committee minutes.

Level II:

- The Radiation Safety Program will conduct an investigation of radioiodine handling procedures. If it is determined that continuation of current operations would cause further uptake, use of radioiodine will be discontinued until further corrective actions can be implemented;
- A report of the investigation and any action taken will be presented to the RSC at the first meeting following completion of the investigation. The details will be included in the RSC minutes.

Bioassay Testing Procedure

The Radiation Safety Program will contact those individuals who work with high radioiodine activities (see Table 9.3) as supplied by the Authorized User and schedule a baseline bioassay. Individuals participating in the program will notify the Radiation Safety Program following their initial contact with radioiodine to schedule the first routine bioassay (to be performed within three (3) days for I-131 or seven (7) days for I-125).

Upon completion of this first routine bioassay, a schedule will be established for further testing. Any participant who will be leaving the university must notify the Radiation Safety Program for a final bioassay well before the departure.

Table 9.4. Bioassay Frequency

Type of Bioassay	When is it Necessary?	How Often?
Baseline or Pre-operational	Initial work with I-125 or I-131 in quantities requiring participation in the bioassay program.	Once, prior to initial work with radioiodines.
Routine	Working with quantities of radioiodine that require participation in the bioassay program.	Within 7 days for I-125 or within 3 days for I-124 or I-131 after completion of the procedure, but no more than once every two weeks. NOTE: After three months of routine bioassays, the frequency may be reduced to quarterly upon the approval of the Radiation Safety Officer.
Diagnostic	An individual has exceeded an action level.	As determined by the Radiation Safety Officer.
Emergency	Potential uptake in excess of 0.1 µCi of I-125 or I-131.	As soon as possible if excess uptake is suspected.
Post operational	Within 3 days, but not less than 6 hours after work with radionuclides is terminated.	Once, before individual leaves the university.

Source: USC Letter to RHB on 8/28/2015, Appendix 22

Guidelines for Working With Other Radioactive Material

Any individual who uses more than 100 mCi per month (30 days) of any radionuclide in an unsealed form, with the exception of Technetium-99m and other radionuclides with an effective half-life of less than eight (8) hours, is required to participate in the bioassay program. The RSO may also require a bioassay to be performed following any accident involving radioactive material where there is a possibility of significant contamination of personnel.

The Radiation Safety Program will contact individuals who are likely to work with high activities of radioactive materials as supplied by the Authorized User and schedule a baseline bioassay. Individuals participating in the bioassay program must submit a urine sample to the Radiation Safety Program within one week of meeting the 100 mCi per month use, or as directed by the RSO. It is the responsibility of the Authorized User and individual staff to recognize when the 100 mCi per month limit is reached.

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10.0 Facilities, Equipment, and Registration

Facilities and Laboratories

All uses of radiation must occur in facilities approved by the RSC, using appropriate equipment, also authorized by the RSC.

Common Laboratory Setup for Radioactive Materials

Laboratories for use with unsealed radioactive materials have the following classifications:

Type A

Specially designed laboratory for handling large activities of radioactive materials with special considerations for shielding, proximity to unrestricted areas, enclosed containment, remote manipulation, effluent control/ monitoring, and security.

Type B

Specially designed radioisotope laboratory equipped with independently vented, filtered fume hoods with high-velocity exhausts and polished, easily cleaned non-absorbing surfaces. Hoods are provided to control possible airborne contamination. Airflow is required to be greater than 100 linear feet per minute[1] when the hood sash is at its normal open position. The hood is separately exhausted and filtered. Type B laboratories may be used for vial storage of activities higher than those permitted for hood or bench top work.

Type C

A conventional chemical laboratory, equipped with adequate ventilation, working fume hoods (if used for containing radioactive material), and polished, easily cleaned, non-absorbing surfaces. Airflow is required to be greater than 100 linear feet per minute[1] when the hood sash is at its normal open position. Special filters and/or design are not generally necessary, but may be prudent in special cases. Type C laboratories may be used for vial storage of activities higher than those permitted for hood or bench top work.

The type of laboratory required for use with unsealed radioactivity depends on the relative toxicity of the radionuclide as well as the amount. Common radionuclides are grouped by their relative toxicity in Table 10.1.

The type of lab necessary for a given toxicity group and activity amount is specified in Table 10.2. Type C labs may increase activity limits of Toxicity Groups 3 and 4 under Type B if they have at least six to 10 air changes per hour and non-porous work surfaces.

1 USC to RHB 8-28-2015, Appendix 10 - Fume Hoods

Table 10.1. Radiotoxicity Groups

Group 1	Pb-210 Po-210 Ra-223 Ra-226 Ra-228 Ac-227 Th-230 Pa-231 Pu-238 Am-241 Am-243 Cm-242 Cm-243 Cm-244 Cm-245 Cm-246 Cf-249 Cf-250 Cf-252 Ra-226
Group 2	Na-22 Cl-36 Ca-45 Sc-46 Mn-54 Co-56 Co-60 Sr-89 Sr-90 Y-91 Zr-95 Ru-106 Ag-110m Cd-115m In-114m Sb-124 Sb-125 Te-127m Te-129m I-124 I-125 I-126 I-131 I-133 Cs-134 Cs-137 Ba-140 Ce-144 Eu-152 (13 y) Eu-154 Tb-160 Tm-170 Hf-181 Ta-182 Ir-192 Tl-204 Bi-207 Bi-210 At-211 Pb-212 Ra-224 Ac-228 Pa-230
Group 3	Be-7 C-14 F-18 Na-24 C1-38 Si-31 P-32 S-35 Ar-41 K-42 K-43 Ca-47 Sc-47 Sc-48 V-48 Cr-51 Mn-52 Mn-56 Fe-52 Fe-55 Fe-59 Co-57 Co-58 Ni-63 Ni-65 Cu-64 Zn-65 Zn-69m Ga-72 As-73 As-74 As-76 As-77 Se-75 Br-82 Kr-85m Kr-87 Rb-86 Sr-85 Sr-91 Y-90 Y-92 Y-93 Zr-97 Nb-93m Nb-95 Mo-99 Tc-96 Tc-97m Tc-97 Tc-99 Ru-97 Ru-103 Ru-105 Rh-105 Pd-103 Pd-109 Ag-105 Ag-111 Cd-109 Cd-115 In-115m Sn-113 Sn-125 Sb-122 Te-125m Te-127 Te-129 Te-31m Te-132 I-130 I-132 I-134 I-135 Xe-135 Cs-131 Cs-136 Ba-31 La-140 Ce-141 Ce-143 Pr-142 Pr-143 Nd-147 Nd-149 Pm-147 Pm-149 Sm-151 Sm-153 Eu-152 Eu-155 Gd-153 Gd-159 Dy-165 Dy-166 Ho-166 Er-169 Er-171 (9.2 hr) Tm-171 Yb-175 Lu-177 W-181 W-185 W-187 Re-183 Re-186 Re-188 Os-185 Os-191 Os-193 Ir-190 Ir-194 Pt-l91 Pt-193 Pt-197 Au-196 Au-198 Au-l99 Hg-197 Hg-197m Hg-203 Tl-200 Tl-201 Tl-202 Pb-203 Bi-206 Bi-212 Rn-220 Rn-222
Group 4	H-3 O-15 Ar-37 Co-58m Ni-59 Zn-69 Ge-71 Kr-85 Sr-85m Rb-87 Y-9lm Zr-93 Nb-97 Tc-96m Tc-99m Rh-103m In-113m I-129 Xe-131m Xe-133 Cs-134m Cs-135 Sm-147 Re-187 Os-191m Pt-193m Pt-197m

Table 10.2. Laboratory Requirements

Radioactivity Group	Minimum Qty	Type of Working Place or Laboratory Required		
	µCi	Type C	Type B	Type A
Group 1	0.1	< 10 µCi	10 µCi	> 10 µCi
Group 2	1.0	< 100 µCi	100 µCi	> 100 µCi
Group 3	10	< 1 mCi	1 mCi - 1 Ci	> 1 Ci
Group 4	100	< 10 mCi	10 mCi - 10 Ci	> 10 Ci

All applications for use that indicate a need for greater than Type C laboratory will require the RSC to consider the specific shielding, proximity of radiation sources to unrestricted areas, and any other specific items or equipment in the facility that are pertinent to radiation safety.

When reviewing facilities where radioactive materials may become airborne, the RSC will take into consideration descriptions of the ventilation systems including pertinent airflow rates, pressures, filtration equipment and monitoring systems. Prospective doses to workers and the public will be considered and kept As Low as Reasonably Achievable (ALARA).

Any changes to Type A or Type B facilities or equipment modification within those facilities will require review and approval of the RSC before implementation.

Other Types of Facilities

Examples of other types of facilities that require additional approval from the RSC and CDPH are listed below.

Positron Emission Tomography (PET) Imaging Center

Positron-emission tomography (PET) is a technology which utilizes short-lived radionuclides, such as F-18, C-11, N-13, O-15, Cu-64 and Zr-89, to deliver high spatial and temporal resolution data for molecular imaging. This type of imaging is important clinically, not only in diagnosis of heart disease and evaluation of Alzheimer's patients, but also in many types of therapy (including cancer therapy). Furthermore, at USC, PET imaging is also used in research to enable scientists to non-invasively visualize, characterize and quantify normal and pathologic processes in vivo at the cellular and subcellular level.

Cyclotron

USC's cyclotron (See Figure 10.1) is a particle accelerator capable of producing a well-defined and high-energy intensity beam of charged particles. This beam strikes the target, which leads to the production of radionuclides, such as F-18, C-11, N-13, O-15, Cu-64 and Zr-89. These isotopes are used to manufacture Positron Emission Tomography (PET) tracers by the use of remotely operated automated synthesis modules. The PET tracers are useful in both medical and research applications.

Figure 10.1. Cyclotron

Source: EH&S

One of the major risks of operating a cyclotron is the high radiation levels that can exist in and around the cyclotron when the target is being bombarded by the charged particles. Therefore, the major consideration in a cyclotron installation is choosing between a vault-shielded and a self-shielded cyclotron device. In the case of USC, we have chosen to install a self-shielded cyclotron, where retractable shielding is integrated into the cyclotron unit to keep the radiation levels around the cyclotron minimal. Area monitors and effluent release monitors installed in and around the cyclotron facility continually monitor the radiation levels during operation, and the requirements for the cyclotron are reviewed and routinely inspected at great lengths by the the cyclotron lab, the USC Radiation Safety program and the California Department of Public Health (CDPH).

Radiochemistry Laboratory

The Positron Emission Tomography Radiochemistry Laboratory contains hot cells for remote isotope handling/ preparation (see Figure 10.2). An area monitor is wall- mounted and in continual operation. The Hot Cells and the Radiochemistry Lab are under negative pressure to prevent materials from escaping from the Hot Cells into the Lab, or from the lab into the common areas. Radiolabeled compounds are moved by hand in a lead container. All work with volatile materials (including chemical processing) are performed in the Hot Cells. Labeled products may be used in further experiments outside the Hot Cells. All waste products are stored in the Hot Cells for decay.

Figure 10.2. Hot Cell

Source: EH&S

Package Receipt Area

In most cases, radioactive materials used at USC are received, inspected, and inventoried in the EH&S Package Receipt Area on the Health Sciences Campus. Direct receipt of packages at other locations is only allowed after approval by the Radiation Safety Program and is generally approved only for very short-lived isotopes (e.g., F-18).

Radioactive Waste Storage Facilities

Each campus has its own Waste Storage Facility (WSF). Radioactive waste is stored in these locations either for decay or until final disposal to a licensed facility. Each WSF has a waste compactor for compacting low-level amounts of radioactivity (excluding radionuclides of iodine). Access to the facilities are limited to authorized Department of Public Safety and authorized EH&S employees.

Animal Handling and Housing Facilities

There are several animal handling and housing facilities located on both campuses. Animals that are used in studies with or treated with radioactive materials must be kept separate from the other animals in the vivaria.

They shall be housed only in cages that have been approved for use by both the Department of Animal Resouces (DAR) and Radiation Safety. The facilities, stalls, or cages will be secured to prevent unauthorized access to the animals. The housing of animals in vivaria that are treated with RAM needs the approval of the Radiation Safety Program and DAR. Note that the facility has to be cleared for general use by EH&S at the end of the project.

Equipment

Devices Containing Sealed Sources

A sealed source is radioactive material that is permanently bonded or fixed in a capsule or matrix. It is designed to prevent the release and dispersal of the radioactive material under the most severe conditions likely to be encountered in normal use and handling. Devices that contain sealed sources are added to a RAM permit but may also require registration with CDPH.

The Radiation Safety Program will inform the Permit Holder if registration is required.

Gas Chromatography Equipment

Gas chromatography (GC) equipment may be outfitted with electron capture detectors (ECD) that have small radioactive sources such as H-3 (tritium) or Ni-63 electroplated onto a metal film. Dismantling these devices for cleaning may release radioactive material; therefore, **DO NOT** dismantle these devices.

If the GC is moved, the Radiation Safety Program/EH&S must be notified of its new location. DO NOT dispose or transfer the device to any other user or facility without notifying the RSO at 323-442-2200 or radsafety@usc.edu.

Liquid Scintillation Counters (LSC)

A liquid scintillation counter (see Figure 10.3) is used to detect small amounts of radioactivity in samples and usually has a small radioactive check source located internally.

Because of this, the Radiation Safety Program/EH&S must be informed before the LSC is moved to a new location. DO NOT dispose of or transfer the device to any other user or facility without notifying the RSO at 323-442-2200 or radsafety@usc.edu.

Figure 10.3. Liquid Scintillation Counter

Source: PerkinElmer

Radiation Detection Instruments

Every laboratory using unsealed radioactive materials must possess (or have easy access to) a suitable instrument for measuring contamination. Contamination can be measured using portable survey instruments for direct reading and/or using a liquid scintillation counter (LSC) or gamma counter for measuring removable contamination on wipes.

There are advantages and limitations to each type of instrument and it is essential that personnel use the correct detector and survey method as determined by the radioisotope of concern.

*Table 10.3. Detector Requirements for Common Nuclides Found at USC**

Isotope	Radiation	Detector Requirement
3H	Low energy beta emitter	LSC only
14C, 33P, 35S	Medium energy beta emitter	GM and/or LSC
32P	High energy beta emitter	GM and/or LSC
125I	Low energy gamma emitter	Thin Crystal (NaI) and/or LSC /Gamma Counter
51Cr	Medium energy gamma emitter	Thick Crystal (NaI) and/or LSC /Gamma Counter
131I	Beta & medium energy gamma emitter	GM or Thick Crystal and/or LSC /Gamma Counter

*Table 10.3 is meant as a guide only. The Radiation Safety Program will review and recommend specific detectors to ensure that they are adequate for monitoring contamination levels.

Portable detectors (see Figure 10.4) are evaluated by the following criteria:

- Sufficient sensitivity to respond to normal radiation background and capable of rapid response;
- Lightweight, readily portable, simple to operate, audible response in addition to visible meter reading, and easily handled by laboratory personnel;
- Easy to calibrate with appropriate standard for instrument function checks;
- Capable of detecting radiation from RAM or sealed source being used. Must be sensitive to 200 dpm/100 cm^2 for all radioisotopes it measures; and
- Accurate to within 10% of the actual calibration source reading on all scales used during routine operations.

Figure 10.4. Portable Detectors

Source: interphysix/Ludlum

Portable survey instruments have varying capabilities depending on the types of probes attached to the meters. The common types of portable probes at USC are identified in Figure 10.5 along with their capabilities.

Liquid scintillation counters (LSC) or gamma counters are other types of detectors used for measuring contamination; however, they are generally non-portable due to their large size.

Figure 10.5. Common Probes

Source: Ludlum/Bee Research

A. Pancake Geiger-Muller (GM) probe (with thin window)
- Used for medium to high energy beta or gamma radiation
- Best for P-32, adequate for S-35, C-14

B. NaI Crystal Scintillation probe
- Thin window: low gamma radiation; Best for I-125 and secondary X-ray production (bremsstrahlung)
- Thick window: medium to high gamma radiation; Best for Cs-137, I-131

General procedures for using an LSC or a gamma counter are to wipe a small piece of soft absorbent material across the possibly contaminated area.

If the same wipe is counted for both gamma and beta radiation, conduct the gamma counting first by depositing the wipe in an empty vial and place in gamma counter. Afterwards, add liquid scintillation cocktail to the vial and wait for the wipe to dissolve before placing the vial in the LSC for beta counting.

Portable detectors have the advantage of being able to scan large areas quickly while LSCs and gamma counters are limited to the area directly swiped. Portable detectors are also able to measure the contamination directly, whether fixed or removable while the LSC or gamma counter can only measure removable contamination. However, the LSC or gamma counter is generally much more efficient i.e., can detect smaller amounts of the contamination.

Note that the LSC is the only method of measuring a very low-energy beta emitter such as H-3.

Radiation-Producing Devices

Radiation-producing devices are defined as devices that generate ionizing radiation as a result of the bombardment of targets by electrons or other types of particles. These devices must be authorized for use through the RSC via the permitting process and in most cases, they must also be registered with the CDPH. Refer to X-ray Producing Device Registration Fact Sheet for details; refer to the X-ray Safety Manual for safety information. The following are examples of radiation-producing devices. Note that fluoroscopic units and linear accelerators fall into this category.

Open X-ray Producing Devices

These devices produce open beam X-rays (see Figure 10.6) and are used mostly for diagnostic and therapeutic purposes in human and veterinary applications (see Fluoroscopy in Research Fact Sheet).

Figure 10.6. Open X-ray Producing Device

Source: EH&S

On rare occasions, some laboratory devices such as X-ray Diffractometers (XRD) are set up in an open beam configuration as well.

Self-shielded or Cabinet X-ray Producing Devices (Closed X-ray Systems)

A cabinet X-ray system contains an X-ray tube installed within a shielded enclosure. The enclosure is made of a material (usually lead) that stops most of the X-ray radiation from leaving the enclosure. The enclosure also serves as a physical barrier that excludes people from the space where X-rays are produced. The following are examples of typical closed X-ray systems.

X-ray Diffractometer (XRD)

X-ray diffraction (XRD) relies on the dual wave/particle nature of X-rays to obtain information about the structure of crystalline materials (See Figure 10.7). The diffraction pattern created by the X-rays is used to identify and characterize the crystal. X-ray diffraction has many applications including thin film analysis, sample texture evaluation, monitoring of crystalline phase and structure, and investigation of sample stress and strain.

Figure 10.7. XRD

Source: EH&S

Cabinet X-ray

A cabinet X-ray system (see Figure 10.8) contains an X-ray tube installed within a shielded enclosure. The enclosure is made of a material, usually lead, that stops most of the X-rays from leaving the enclosure. The enclosure also serves as a physical barrier that excludes people from the space where X-rays are produced. Cabinet X-ray systems at USC are used primarily for analyzing tissue samples.

Figure 10.8. Cabinet X-ray

Source: Marietta NDT

X-ray Irradiator

Self-shielded X-ray Irradiators (See Figure 10.9) at USC are used to irradiate small samples such as cell lines or small animals. The X-ray radiation ionizes the sample material, but does not cause or induce radioactivity i.e., the material does not become radioactive itself.

Figure 10.9. X-ray Irradiator

Source: Precision X-ray

Irradiators are adequately shielded with lead. The dose rate around the outside of the irradiators does not exceed 0.1 mR/hr at 30 cm from sides.

Note that 0.1 mR/hr can register several thousand cpm on a portable radiation detector.

Electron Microscopes

Electron microscopes produce X-rays internally. These X-rays are produced when scattered electrons from the primary electron beam strike metal parts within the microscope. The X-rays may escape through weak points in the equipment, such as between the gasket-sealed junction of two sections of the column, or at the top of the scope where the electrical cables are attached to the gun. Newer electron microscopes are adequately shielded so that X-rays do not escape the microscope.

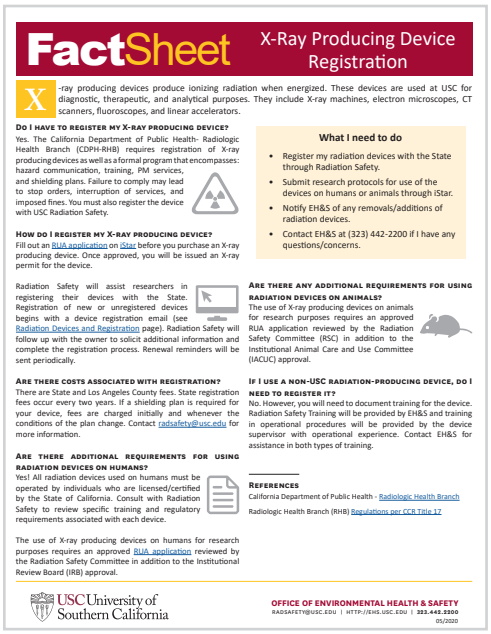
Registration of X-ray Producing Devices

The State of California requires that all radiation-producing devices be registered with the state. (See Figure 10.10, X-ray Producing Device Registration Fact Sheet). Examples of the specific types of radiation-producing devices that require registration include:

- Both fixed and mobile X-ray units
- Both fixed and mobile fluoroscopy units
- Closed cabinet X-ray units
- Electron microscopes
- X-ray diffraction units
- Computer Tomography (CT) units
- MicroCT units
- Dual-energy X-ray absorptiometry (DEXA) units

For a detailed description and complete list of devices that require registration with the State of California, please consult the State of California Instructions for RH 2261N (see Categories of Radiation Devices) document.

Figure 10.10. X-ray Producing Device Registration Fact Sheet



FactSheet — X-Ray Producing Device Registration

X-ray producing devices produce ionizing radiation when energized. These devices are used at USC for diagnostic, therapeutic, and analytical purposes. They include X-ray machines, electron microscopes, CT scanners, fluoroscopes, and linear accelerators.

Do I have to register my X-ray producing device?
Yes. The California Department of Public Health- Radiologic Health Branch (CDPH-RHB) requires registration of X-ray producing devices as well as a formal program that encompasses: hazard communication, training, PM services, and shielding plans. Failure to comply may lead to stop orders, interruption of services, and imposed fines. You must also register the device with USC Radiation Safety.

How do I register my X-ray producing device?
Fill out an RUA application on iStar before you purchase an X-ray producing device. Once approved, you will be issued an X-ray permit for the device.

Radiation Safety will assist researchers in registering their devices with the State. Registration of new or unregistered devices begins with a device registration email (see Radiation Devices and Registration page). Radiation Safety will follow up with the owner to solicit additional information and complete the registration process. Renewal reminders will be sent periodically.

Are there costs associated with registration?
There are State and Los Angeles County fees. State registration fees occur every two years. If a shielding plan is required for your device, fees are charged initially and whenever the conditions of the plan change. Contact radsafety@usc.edu for more information.

Are there additional requirements for using radiation devices on humans?
Yes! All radiation devices used on humans must be operated by individuals who are licensed/certified by the State of California. Consult with Radiation Safety to review specific training and regulatory requirements associated with each device.

The use of X-ray producing devices on humans for research purposes requires an approved RUA application reviewed by the Radiation Safety Committee in addition to the Institutional Review Board (IRB) approval.

What I need to do
- Register my radiation devices with the State through Radiation Safety.
- Submit research protocols for use of the devices on humans or animals through iStar.
- Notify EH&S of any removals/additions of radiation devices.
- Contact EH&S at (323) 442-2200 if I have any questions/concerns.

Are there any additional requirements for using radiation devices on animals?
The use of X-ray producing devices on animals for research purposes requires an approved RUA application reviewed by the Radiation Safety Committee (RSC) in addition to the Institutional Animal Care and Use Committee (IACUC) approval.

If I use a non-USC radiation-producing device, do I need to register it?
No. However, you will need to document training for the device. Radiation Safety Training will be provided by EH&S and training in operational procedures will be provided by the device supervisor with operational experience. Contact EH&S for assistance in both types of training.

References
California Department of Public Health - Radiologic Health Branch
Radiologic Health Branch (RHB) Regulations per CCR Title 17

USC University of Southern California

OFFICE OF ENVIRONMENTAL HEALTH & SAFETY
RADSAFETY@USC.EDU | HTTP://EHS.USC.EDU | 323.442.2200
05/2020

http://tiny.cc/usc-xray-registration

Purchase, Replacement and Disposal of Radiation-Producing Devices

Anyone who is planning to purchase, replace or dispose of a radiation-producing device at USC should immediately notify the Radiation Safety Program by calling 323-442-2200 or emailing Radsafety@usc.edu. This notification applies to both devices **owned by USC** and devices **on lease to USC** on a temporary basis.

Permit Application for Radiation-Producing Devices

The acquisition, installation, and use of devices that emit ionizing radiation require the authorization of the Radiation Safety Program.

Any qualified faculty member who wishes to become an Authorized User of radiation-producing devices must submit an application to the Radiation Safety Committee via an iStar application describing:

- Department/owner contact information
- Device manufacturer
- Device type and model
- Serial number
- User manual
- Number of X-ray tubes
- Proposed location of the device
- Use protocol/ technique chart
- Facility description
- Date of receipt
- Emergency procedures

A permit will be issued for the specific uses indicated on the application upon approval.

Training Requirements

See Section 5 Inspection Program and Training – Training Requirements for details concerning requisite courses. Safety instruction will include: proper use of interlocks; safety features and operating controls; security requirements for operating controls/ unoccupied rooms; radiation levels in the primary beam and scattered from objects; and knowledge of and supervised experience with experimental protocols. If use involves medical application, evidence of appropriate state licensure/certifications will also be required.

Other Requirements for X-ray Producing Devices

PPE and Hygiene

See Section 7 Good Laboratory Practices - Personal Protective Equipment (PPE) and Hygiene.

Hazard Communication for X-ray Facilities

All areas where X-ray units are located must be posted as follows:

- Entrances to all rooms containing open beam radiation-producing devices must have the following signage:
  - "Caution X-rays", "Caution X-ray Radiation", or "Caution Radiation"

Source: EH&S

  - The name and telephone number of a person to be contacted in case of emergency
- A label or sign that reads *"Caution X-ray: This Equipment Produces Radiation When Energized"* must be placed near the energizing switch.
- Emergency procedures must be posted near the equipment controls.
- A label or sign that reads "Caution: High Intensity X-ray Beam" must be placed in the area immediately adjacent to each tube head not provided with an interlock. The sign must be clearly visible to any person operating, aligning or adjusting the unit and/or handling or changing a sample.

Devices must be provided with a visual indicator located on or near the tube head which indicates when X-rays are being produced. It is recommended that the indicator be an assembly consisting of two lights, wired in parallel, indicating "X-rays On".

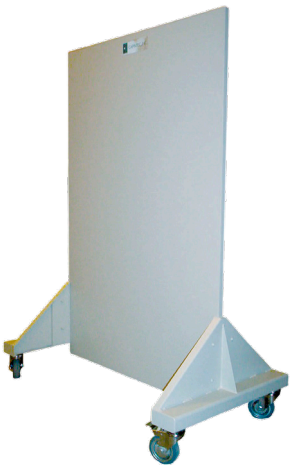
If one of the lights burns out, the operator must replace it before leaving the room or leave a note on the light assembly indicating the bulb is burned out.

A single bulb assembly may be used only if it is wired so that failure of the bulb will cause X-ray production to stop. An unlighted warning bulb does not necessarily mean that X-rays are not being produced. The light only indicates when X-rays are being produced.

Shielding and Access Control

The utilization of shielding (see Figure 10.12) and access control is dependent on the unit type. Self-shielded radiation producing devices typically do not require additional shielding. However, open beam radiation-producing devices require a shielding plan on file with the Los Angeles County Radiation Management Office.

Figure 10.12. X-ray Shield



Source: MedicalEXPO

It will include actual operating conditions such as workload, use factor, occupancy, and attenuation of useful beam by patients or objects.

The Radiation Safety Program will assist the Permit Holder in the preparation and submittal of the shielding plan, but (s)he is responsible for submittal fees and any consultancy fees for technical aspects of the plan.

Any future changes to the operating conditions may require submittal of a new shielding plan.

Safe Operation

For safe operation of X-ray equipment, ensure that:

- All unused X-ray ports are closed;
- Both the warning lights and the meters on the console are checked, prior to opening a shutter;
- The room is locked whenever an energized X-ray device is left unattended; and
- Proper PPE is worn in the laboratory especially around electrical equipment.

In the event of an accident or unusual incident involving a radiation-producing device:

1. Turn off (or de-energize) the device if safe to do so.
2. Notify the Radiation Safety Program.
3. Record all important parameters (e.g., mA, kVp, and distance from the X-ray source, the nature and duration of the possible exposure).

Test and Inspection

After the initial set up and after each subsequent major change in experimental set up, the operator must visually inspect each X-ray port and survey the device for scattered or leakage radiation. Exposure readings external to the primary or secondary shields above background must be reported to the Permit Holder (or designee).

Routine equipment surveys will be documented and maintained for review by the Radiation Safety Program.

Note: Radiation survey instruments are useful only to indicate the presence of unwanted radiation and to trace the origin of leakage radiation, but are not capable of analytical measurements of the X-rays.

Repairs

Do not attempt to repair faulty X-ray equipment unless highly trained. Always consult the Permit Holder or his/her designee first.

Repairs to the high voltage section must not be made unless the primary leads are disconnected from the high voltage transformer, and a signed and dated notice is posted near the "X-ray On" Switch. Turning off a circuit breaker is not considered a disconnect. Refer to the Lock Out/Tag Out program.

Do not attempt to align X-ray cameras without first consulting an experienced person. Alignment procedures require special training and knowledge to reduce hazards. Special care is required when one power supply is connected to more than one X-ray tube.

11.0 Emergency Response

Minor Spill

A minor spill is defined by the following:

- Small area of contamination
- No external or internal contamination of personnel

RAM users may clean minor spills by following the procedures outlined below. RAM users may also contact EH&S at (323) 442-2200 for assistance if they lack spill remediation materials and/or training.

Necessary Supplies

Category	Items
PPE	Disposable compatible gloves, lab coat, safety glasses/splash goggles, and disposable shoe covers
Clean-Up Materials	Paper towels, soap and water or cleaning solution, and solid radioactive waste container
Survey Equipment	Survey meter (GM Pancake Probe or Sodium Iodide crystal), and filter paper wipes

NOTE: Check gloved hands and shoe covers periodically for contamination using a survey meter. Change the glove/shoe cover if contamination is detected.

Procedure

1. Notify all persons in the area that a spill has occurred.
2. Put on two layers of disposable gloves, a lab coat, safety glasses/splash goggles, and disposable shoe covers (plastic bags may be used to cover shoes).
3. Cover the spill with absorbent paper or an absorbentpad. If solids are spilled, moisten the pad with water.
4. Using a marker and the survey meter, carefully outline the surfaces that give a reading above background, so that the extent of contamination is clear.
5. Rub the contaminated area from the perimeter towards the center with a rag or paper towel, using a clean portion of the rag for each application.
6. Carefully fold the absorbent paper or pad, insert it in a plastic bag, and dispose of it in a radioactive waste container. Do the same for any rags used.
7. Wash the contaminated area with soap and water and a new rag, working from the outside of the spill to the center. Place all contaminated cleaning rags in the plastic bag for the radioactive waste container.
8. With the survey meter, check the area around the spill, hands, shoes, and clothing for contamination. Repeat step 7 until all areas give background readings.
9. Once no contamination is detected, perform a wipe test of the spill area and analyze with a liquid scintillation counter. If the wipe is contaminated, continue to decontaminate and wipe test until the wipes come back clean.
10. Ensure there is no contamination on personnel, personnel's shoes, clothing, or hands in the surrounding area.
11. Document the incident and send to Radiation Safety (radsafety@usc.edu) within 24 hours, and follow any additional guidance offered by Radiation Safety.

If the spill involves tritium, it cannot be detected using a survey meter since it only emits low-energy beta particles.

Clean the suspected areas as described above, and take wipe samples from all involved areas to verify successful decontamination. Review this helpful video walkthrough of decontamination after a minor spill.

Decontaminating Equipment

If research equipment is contaminated, it may be decontaminated using the same method as described above. If the device is energized, turn it off before decontaminating. Use the survey meter to detect areas of contamination and wipe using a cleaning solution until the survey meter measures the surface as background. Take wipe samples of the surface as a final check. If feasible, the equipment may be soaked in a cleaning solution to remove radioactive material.

Permanently Contaminated Surfaces

If a surface cannot be sufficiently decontaminated to reduce radiation levels to background, it must be demarcated with tape labeled "RADIOACTIVE." Minimize activity of personnel in that area and employ shielding, if necessary. A good estimate for radioactive decay to background levels is the ten (10) half-lives rule. Also, periodic surveys of the contaminated area to monitor decay is an option. EH&S will need to be contacted to perform a final survey, and if it is deemed safe, the tape may be removed and the surface treated as normal.

Major Spill

A major spill may result in any or all of the following:

- Large surface area contaminated
- Any internal contamination of personnel (ingestion, injection, spill on open wound)
- Excessive external radiation exposure to personnel
- Serious delay in work procedures

Radionuclide Millicurie Limit

Hydrogen-3 (Tritium)	100
Carbon-14	10
Fluorine-18	10
Phosphorous-32	10
Sulfur-35	10
Chromium-51	100
Iodine-123	10
Iodine-125	1
Iodine-131	1

Additionally, if more millicuries of an isotope are spilled than its limit number in the above table, it is considered a major spill. For example, a 5 mCi spill of F-18 would be minor, but a 5 mCi spill of I-131 would be major.

CALL DPS IMMEDIATELY @ (213) 740-4321 UPC or (323) 442-1000 HSC if a major radioactive spill occurs.

Major Spill Clean-Up

1. Notify all persons not involved in the spill to vacate the room and deny entry.
2. Confine all potentially contaminated personnel to a designated "clean" area to prevent the spread of contamination
3. Don the proper PPE: e.g. a lab coat and two layers of disposable gloves.

4. Cover the spill with plenty of absorbent paper to prevent the spread of contamination, but DO NOT attempt to clean up
5. If possible, return the stock vial(s) to their shielded containers, but only if it can be done without significantly increasing your radiation exposure
6. Notify Department of Public Safety (DPS) 213-740-4321, the Radiation Safety Program 323-442-2200, and laboratory supervisor immediately.
7. Survey all personnel for contamination. Decontaminate personnel by removing contaminated clothing and flushing contaminated skin and hair with lukewarm water followed by washing with a mild soap.
8. Remove and store contaminated clothing for evaluation by the Radiation Safety Program.
9. Follow the instructions of the Radiation Safety Program (e.g., further decontamination techniques, surveys, provision of bioassay samples, requested documentation).

Personnel Contamination

Eye/Skin Contact

For small areas of incidental contact (except eyes), wash with mild soap and large amounts of lukewarm water. Wash your skin gently. Do not scrub aggressively, as this may scrape the skin and cause abrasions, allowing the contamination to enter your body.

For large areas of contact and/or eye exposure:

1. Immediately go to the emergency shower/ eye wash facility. Activate the shower and remove all contaminated clothing.
2. Flush affected body area with water for at least 15 minutes.
3. If the eyes are contaminated, forcibly hold them open and flush for least fifteen (15) minutes.
4. Resume flushing area with water if pain continues.
5. Notify radsafety@usc.edu.

Malfunction of Radiation-Producing Devices

In the event of any malfunction in any radiation-producing device or related safety systems (including safety alarms and interlocks), the following actions must be taken:

1. Exit the room immediately.
2. Contact the RSO 323-442-2200 during normal hours; contact DPS 213-740-4321 after hours, on holidays, or on weekends.
3. Lock doors, post a warning sign, and have the area guarded at a known safe distance to ensure against accidental exposure.

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12.0 Injury and Incident Reporting

Injury/Incident Reporting

Serious Injury or Illness Reporting

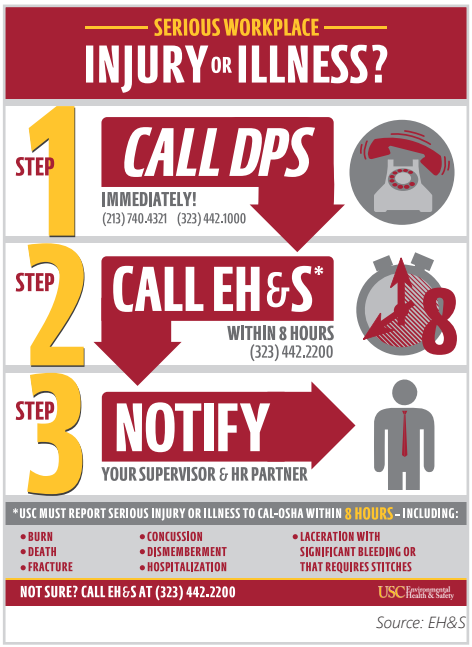
Employers in the State of California are required to notify Cal-OSHA within 8 hours of all serious occupational injuries and illnesses, or any workplace injury or medical event which results in an employee staying in hospital overnight or longer. EH&S investigates and records incidents at USC and determines if Cal-OSHA notification is required, or if other actions are needed. Employers who fail to report serious occupational injury or illness within eight hours are subject to a $5,000 penalty.

It is essential for PIs, Lab Managers, other laboratory personnel, and HR Partners to notify EH&S as soon as possible in the event of the following:

- Exposure to harmful material (chemical, biological, or radiological) or radiation
- Eye injury or exposure, regardless of how minor it may appear
- Needlestick injury
- Chemical or thermal burn
- Cuts or lacerations, if there is significant bleeding, stitches are required, or there are complications such as hazardous materials contamination or embedded broken glass.
- Concussion (actual or suspected)
- Fracture
- Dismemberment
- Death
- Any event requiring transport to hospital, e.g. sudden illness

For a work-related injury or illness that requires emergency response, follow the procedures on the Emergency Notification Protocol web page. Post the 1-2-3 Serious Injury Reporting flier (see Figure 12.1)in a conspicuous area of the laboratory to help the research group become familiar with the process. It is also recommended to also post the 1-2-3 flyer in offices and common areas. Contact EHS@usc.edu for printed copies of the poster.

Figure 12.1. 1-2-3 Emergency Notification



Source: EH&S

Non-Serious Injury or Illness Reporting

Even if an injury or illness does not meet the requirements for Cal-OSHA reporting, it is important that the affected employee receives proper care (see Workers' Compensation web page for details).

Near Misses

A near miss is an unanticipated event that did not result in harm/injury, but had the potential to do so.

Examples would be:

- Radioactive contamination of personnel (external or internal)
- Radioactive contamination of a large area or areas beyond a laboratory's resources to contain it
- Release of radioactive material to the environment
- Loss of radioactive material (including radioactive waste)
- Known or suspected excess radiation exposure to the general public or lab personnel
- Loss or damage to personnel dosimeters

Notify the Radiation Safety Program (radsafety@usc.edu or 323-442-2200) immediately when any of these events occur. The RSO will maintain a database of accidents and near misses for educational purposes to increase user awareness of potentially hazardous situations.

How to Report

The USC Department of Public Safety (DPS) has continuous access to EH&S via a rotating 24-hour EH&S on-call personnel. DPS is also the contact between USC and emergency services (fire, ambulance, etc.).

DPS is the first contact in an emergency situation, or when a significant incident needs to be reported outside normal working hours. DPS may be reached as follows:

- DPS Emergency Numbers: 213.740.4321 (UPC) and 323.442.1000 (HSC)
- DPS Non-Emergency Numbers: 213-740-6000 (UPC) and 323-442-1200 (HSC)

It is strongly recommended that all PIs and laboratory personnel have DPS emergency and non-emergency numbers pre-programmed into their mobile phones. It is also recommended for the numbers to be displayed adjacent to fixed-line phones in labs and offices.

Within normal working hours, and in the absence of an emergency, EH&S should be contacted directly on (323) 442-2200 to report safety incidents. Further information on emergency notification and incident reporting may be found at the Emergency Notification and Incident Reporting web page.

Incident Investigation

Upon being notified of a laser safety incident, the RSO (or designee) will conduct an accident investigation which includes the following:

- Interviews with injured workers and witnesses
- Examination of the workplace for factors associated with the accident/exposure
- Determination of possible cause(s) of the accident/exposure
- Corrective action(s) to prevent the accident/exposure from recurring
- Documentation of the findings and corrective actions taken

If an incident results in significant injury, is a "near miss" (i.e. could easily have been much more severe), or reveals systemic problems in safety management and culture within a research group, then the report may be circulated more widely, with appropriate recipients potentially including:

- Department/School
  - Safety Officer/Coordinator (when position exists)
  - Senior management (Head of Department, Dean, Vice Deans)
  - Safety committee chairperson
- USC Senior Management (Associate Senior Vice President for Administrative Operations, Senior Vice President for Administration, Vice President of Research)
- USC-wide safety committee chairpersons and members (CCSC, RSOC, others as appropriate)

The purpose of the RSO (or designee)/EH&S investigations is to clarify what happened and to identify contributing factors, in order to learn lessons and thereby improve future safety. Incident reports will normally contain specific recommendations for addressing any safety deficiencies or contributing factors identified during the investigation. It is important for PIs and laboratory personnel to understand that RSO (or designee)/EH&S incident investigations are not intended to be punitive or to apportion blame.

Personnel are expected to cooperate fully with RSO (or designee)/EH&S incident investigations by providing full and accurate information, in accordance with USC Policy - Cooperation with Compliance Investigations.

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Appendix A Radiation Safety Fact Sheets, Guide Sheets, and Forms

Assessment

Radiation Safety Inspection Process Flow Chart	Radiation Safety Inspection Process

Fact Sheets/Guide Sheets

Cleaning Radioactive Contamination	http://tiny.cc/usc-clean-rad-contam
Electron Microscope Safety Guide Sheet	http://tiny.cc/usc-EMsafety-gs
Fluoroscopy in Research	http://tiny.cc/usc-ehs-fluoroscopy
General Licensed Radioactive Material	http://tiny.cc/usc-genL-RAM-gs
Iodination Safety	http://tiny.cc/usc-iodination-safety
Laser Safety	http://tiny.cc/usc-lasersafety-fs
Laser Safety Eyewear	http://tiny.cc/usc-lasereyewear-fs
Personnel Monitoring Devices - Radiation	http://tiny.cc/usc-ehs-fs-radMntr
Radiation Use Authorization (RUA) - RAM	http://tiny.cc/usc-fs-rua
Radioactive Contamination Checks	http://tiny.cc/usc-ehs-radchk
Radioactive Material Handling Precautions	http://tiny.cc/usc-ehs-RAM-hndl
Radioactive Material Purchase	http://tiny.cc/usc-ehs-RAM-buy
Radioactive Waste Disposal	http://tiny.cc/usc-radwst-gs
Radiofrequency Radiation	http://tiny.cc/usc-rf-rad-fs
Rodent Irradiation	http://tiny.cc/usc-rodentIrrad-gs
Transport/Shipment of Radioactive Materials	http://tiny.cc/usc-ehs-fs-RAMxprt
Uranyl Compounds	http://tiny.cc/usc-ehs-fs-Ucmpds
X-Ray Producing Device Registration	http://tiny.cc/usc-xray-registration

Forms

Categories of Radiation Machines Requiring Registration by the State of California	Categories of Radiation Machines
Declaration of Pregnancy Form[1]	http://tiny.cc/usc-ehs-pregLtr
Dosimeter Add/Delete Form	http://tiny.cc/usc-dosm-app
How to Enter Contamination Survey in EHSA (SOP)	http://tiny.cc/ehsa-radSrvy
Monthly Contamination Check Form	http://tiny.cc/usc-ehs-radChk-ff
Notice to Employees	http://tiny.cc/usc-ehs-rhb2364
NRC Guide 8.13 Prenatal Rad Exposure	http://tiny.cc/nrc-prenat-radExp
Radiation Safety Emergency Procedures	http://tiny.cc/usc-ehs-radEmerProc-ff
Transfer/Shipment of Radioactive Materials	http://tiny.cc/usc-ehs-xfer-RAM-ff

[1] Fillable form

Appendix B EH&S Forms

Other

Employee Training History Form	Employee Training History (downloadable[1] PDF)
Safety Meeting Minutes	Available at the Office of Environmental Health & Safety
Site-Specific Training Record Form	Site-Specific Training Record (downloadable[1] PDF)

Assessment

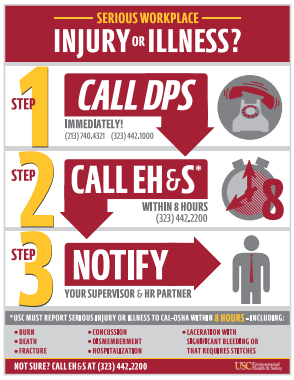
Lab Self-Inspection Guide	Lab Self-Inspection Guide (downloadable[1] PDF)
High Hazard Operations Analysis Form	HazOps Template (downloadable Word[2] doc)
Online Ergonomic Self-Evaluation	Ergonomic Self-Evaluation (online fillable form)
PPE Inspection Checklist	PPE Inspection Checklist (downloadable[1] PDF)

Incident Reporting

Manager's Report of Incident Form	Report of Incident (downloadable[1] PDF)
Incident Investigation Report Form	Incident Investigation Report (downloadable[1] PDF)
Online Report a Safety Concern Form	Report a Safety Concern (online fillable form)
Volunteer Injury or Illness Report	Volunteer II Report (downloadable[1] PDF)
Workers' Compensation Form	WC form (downloadable[1] PDF)

Emergency Notification

1-2-3 Emergency Notification Poster	1-2-3 Poster (downloadable PDF)



Source: EH&S - http://tiny.cc/usc-123

[1] Downloadable PDF forms are fillable.

[2] Word document is fillable.

Office of
Environmental
Health and Safety

(323) 442-2200
ehs@usc.edu