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Campus Safety Health and
Environmental Management Association

Radiation Safety

Contact Chapman University EH&S
with any questions on university-specific practices

SAFETY
FIRST

Objectives

- Administrative Review
- Radioactive Waste
- Radiation Incidents
- Contamination Surveys & Postings
- Radiation Source Security
- ALARA

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Administrative Review

- Use and possession of radioactive materials or radiation producing devices is governed by the Nuclear Regulatory Agency and Agreement States.
- To determine if your state is an Agreement State or Non-Agreement State, visit the Directory of Agreement State and Non-Agreement State Directors and State Liaison Officers.

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Administrative Review *(Continued…)*

- Specific regulations and policies are published in order to guide radiation programs.
- Visit the NRC Regulations Title 10, Code of Federal Regulations for complete federal rules.

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Administrative Review *(Continued…)*

- This training is meant to offer an overview of radiation safety in research facilities.
- It is not meant to replace site-specific, research-specific training offered by individual institutions.

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NRC License

- NRC's regulatory process has five main components:
  - Developing regulations and guidance for our applicants and licensees
  - Licensing or certifying applicants to use nuclear materials or operate nuclear facilities or decommissioning that permits license termination
  - Overseeing licensee operations and facilities to ensure that licensees comply with safety requirements

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NRC License *(Continued…)*

- NRC's regulatory process has five main components:
  - Evaluating operational experience at licensed facilities or involving licensed activities
  - Conducting research, holding hearings to address the concerns of parties affected by agency decisions, and obtaining independent reviews to support our regulatory decisions

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NRC Regulatory Process Overview

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Agreement State Licensing

- Agreement States, have entered into agreements with NRC that give them the authority to license and inspect byproduct, source, or special nuclear materials used or possessed within their borders.

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Agreement State Licensing *(Continued…)*

- Any applicant, other than a Federal agency or Federally recognized Indian tribe, who wishes to possess or use licensed material in one of these Agreement States should contact the responsible officials in that State for guidance on preparing an application. These applications should be filed with State officials, not with NRC.

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Isotope Ordering

- Radioactive material purchasing is governed by the institution's license for the use of radioactive materials.
- Procurement of all radioactive materials requires different levels of authorization and accountability, based on each institution's license and safety programs.

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Isotope Ordering *(Continued…)*

- Institutions establish programs to review uses, storage and disposal of radioactive materials. Often, specific researchers, laboratories, or departments may only be authorized obtain and use radioisotopes specifically listed in his/her currently approved protocol authorization.

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Isotope Ordering *(Continued…)*

- Place the package is a secure location and open only after proper safety and contamination inspections have been completed (swipe tests, meter survey, inventory control mechanism).
- This safety inspection documentation should be maintained for compliance purposes and available for review from outside regulatory agencies.

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Isotope Shipping

- Shipments of radioactive materials must meet the proper shipping and handling specifications under U.S. Department of Transportation or IATA. Next line
- All shippers shall have a current Shipping Certification prior to shipping radioactive materials (Example: FedEx has a web-accessible Hazardous Material Shipping Guide)

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Isotope Shipping *(Continued…)*

- Proper shipping of these materials often requires special considerations. For shipping information, consult the DOT Radioactive Material Regulations Review.

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Radioactive Waste

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Radioactive Waste

- All radioactive wastes from research laboratories shall be disposed of with efforts to minimize the hazards to personnel, property or community
- Each researcher must ensure, prior to the procurement of any radioactive materials, that a satisfactory waste disposal method exists and proper receptacles are in place

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5 Categories of Radioactive Waste

- (1) Solids
  - Absorbent padding
  - Protective coverings and Plastic/rubber gloves
  - Tubing
  - Glassware
  - Plastic, Paper and Metal,
- All items above have become contaminated during research protocols and contain little to no liquid by volume.

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5 Categories of Radioactive Waste *(Continued…)*

- (2) Liquids
  - Solutions, buffers and rinses, that have become contaminated during research activities.
  - Liquid radioactive waste consists of aqueous or organic materials which must be segregated.
  - These wastes should also be segregated according to your institution's safety guidelines.
  - Best practices indicate no radioactive waste is to be disposed via the sanitary sewer or sink

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5 Categories of Radioactive Waste *(Continued…)*

- (3) Liquid Scintillation Waste
  - Segregated from other liquids
- (4) Biological/Animal Carcass
  - Biologically active or remains of animals which have been subjected to radioactive material protocols.
  - These include animal carcasses, pathological waste, microbiological waste, etc.
  - These wastes may be frozen.

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5 Categories of Radioactive Waste *(Continued…)*

- (5) Sharps/Broken Glass
  - Sharp objects or broken glass that have become contaminated during research protocols.
  - These may include needles, razor blades, Pasteur pipettes, broken glass, etc.
- Waste containers must be properly labeled to identify the contents.
- Waste containers must be shielded to keep dose rates below 2 millirem per hour.

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Radiation-Related Emergencies

The following may constitute an incident or emergency:

- Loss or theft of any radioactive material or radiation-producing device
- Personnel contamination that cannot be removed after two gentle washes with warm water and mild soap
- Removable contamination in unrestricted areas such as hallways, offices and vehicles which exceed the regulatory limits

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The following may constitute an incident or emergency: *(Continued…)*

- Intake of radioactive material by inhalation, ingestion, skin absorption, or injection through the skin or wound
- Accidental or unmeasured releases of radioactive material to the environment
- Potentially high radiation exposure to an employee or member of the general public

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Emergency Action Plans

- Radioactive material spills in a laboratory setting can be classified as minor or major incidents.
- Major incidents are those, which may cause an external dose in excess of 5 rem to the entire body.

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Emergency Action Plans *(Continued…)*

- Lab personnel should prepare for incidents by establishing an emergency action plan which includes the following elements:
  - Preparation of a spill kit with supplies suitable for decontamination efforts(i.e., paper towels, cleaning agents, disposable gloves, etc.)
  - An understanding of how personal injuries will be handled, the location of first aid supplies and how to contact the proper personnel for emergency medical aid. Life-saving or first aid measures should ALWAYS take precedence over radiation hazards and decontamination efforts.

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Emergency Action Plans *(Continued…)*

- A knowledge of how to assess the severity of the incident and what the proper reporting procedures are for notifying emergency response personnel. Call a local emergency assistance agency if needed.
- An understanding of how to secure the lab area, perform simple decontamination procedures correctly and complete written documentation of the survey results.

- It may be necessary to post all lab entrances with a warning sign in contamination situations.

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Radiation-Related Emergencies

- When a radioactive material spill occurs, proceed with caution and notify safety officials, if required by your institution, with the following information:
  - Laboratory location of the spill (building, room number)
  - Identity of the caller
  - Extent and severity of personnel injuries, if any
  - Radionuclide(s) involved

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Radiation-Related Emergencies *(Continued…)*

- Amount of radioactive material involved (in µCi or mCi)
- The chemical and physical form of the material (for airborne releases ALWAYS remove all personnel from the lab and have them assemble in a common area for contamination assessment)

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Decontamination Procedures

- To clean up a contamination, proceed with caution and do the following:
  - Wear proper PPE and dosimeter prior to decontamination.
  - Using absorbent material, clean the spill from the outside perimeter of a spill area toward its center, to minimize the contamination. Dispose of all cleaning materials in the proper radioactive waste receptacle and note the spilled amount of the associate log of use form.

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Decontamination Procedures *(Continued…)*

- Once the spill is removed, perform swipe tests of the area to
  ensure all contamination is removed. Keep a copy of the results for inspection review.
- If radioactive contamination remains after all decontamination procedures are completed, notify your safety professionals for further assistance.

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Radiation Postings and Surveys

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Radiation Postings

- Any accessible area in which radiation levels could result in an individual receiving a dose in excess of 5 millirem in 1 hour at 30 centimeters from the source requires signage indicating “Caution Radiation Area”.
- Radiation workers should also ensure that all laboratory equipment and glassware within the laboratory is properly labeled to indicate the presence of radiation sources.

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Radiation Postings *(Continued…)*

- "No radioactive material beyond this point" or "No food or drink allowed in refrigerator" signs all serve an informational purpose for staff and students.
- Radiation safety regulations require the posting of a "Notice to Employees" sign (or similar to) in laboratory settings where radioactive materials or radiation-producing devices are used.

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Radiation Surveys

- Any laboratory storing or using unsealed sources of radioisotopes is required to perform direct surveys with a portable survey meter and indirect contamination surveys known as swipe tests for removable contamination.
- A general survey of the entire lab is required if radioactive materials are used in experimental work. Prudent practices would include surveying storage-only areas of a laboratory as well.

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Radiation Surveys- Frequency

- Prudent practices justify completion of swipe tests immediately following radioisotope use. Safety offices establish swipe frequencies based on their institution and state's standards.
- Required lab contamination surveys that are missed for a particular frequency cannot be "caught up" in a following interval.

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Radiation Surveys – Action levels

- As a rule of practice, swipe survey results exceeding 500 dpm indicate contamination that must be reduced below this level.
- Direct contamination survey instrument results exceeding 3 times the background level must be decontaminated below this level.
- Any decontamination activities should be documented and maintained in the Radiation Safety Manual for review during regulatory inspections or site visits.

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Radiation Security

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Radiation Source Security

- The security of radioactive materials and radiation-producing devices is an extremely important issue.
- All users of radiation sources are required by regulations to take active measures that prevent access by unauthorized persons to these materials.

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Radiation Source Security

- The practical application of source security involves:
  - Locking all entrances to a laboratory whenever authorized workers are absent - otherwise the radiation sources must be secured in a locked storage area within the lab.
  - Inquire about the identity of any unknown persons who may enter the laboratory or loiter nearby the entrance.

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Radiation Source Security *(Continued…)*

- Only authorized personnel are allowed access to these areas with the borrowing of identity cards or “piggy backing” being strictly prohibited.

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Radiation Source Security *(Continued…)*

- Fingerprints and background checks may be necessary to have unescorted access to high security areas.
- Security site inspections are completed on an annual basis for storage areas and other identified locations; security in labs should be challenged during each inspection by Safety representatives.

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Exposure and ALARA

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Exposure and ALARA

- Radiation Safety regulations require the use of reasonable procedures and engineering controls to achieve minimal occupational doses for radiation workers and the general public.
- This policy is known as ALARA, which stands for As Low As Reasonably Achievable.

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Exposure and ALARA *(Continued…)*

- An effective ALARA program is only possible when all persons involved make a commitment to safety. This includes the Radiation Safety Office staff, the Radiation Safety Committee, research faculty and all radiation workers.
- A practical implementation of the ALARA concept involves several aspects, including, but not limited to:
  - using personal protective equipment
  - employing good work practices and contamination control measures

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Exposure and ALARA *(Continued…)*

- wearing dosimetry
- using effective shielding and fume hoods
- using radiation survey instrumentation
- observing proper waste disposal procedures
- maintaining written documentation of all survey results
- observing proper lab security measures

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Exposure Limits

- Radiation Safety personnel should monitor radiation worker's occupational exposure in regards to the Annual Occupational Dose Limits and ALARA Action Levels for Adult Radiation Workers.
- Should a radiation worker reach the ALARA Action level, an investigation ensues. ALARA levels should be set by each institution, for what is most appropriate for that radiation work environment.

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Exposure Limits

Applicable Dose Limit	**Annual Limit** (millirem)
Whole Body Dose Equivalent	5,000
Extremity Dose Equivalent	50,000
Eye (Lens) Dose Equivalent (LDE)	15,000

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ALARA Action level

- Radiation workers who have the potential to receive greater than 10% of their annual limit of 5,000 millirem dose (i.e., 500 millirem) for the whole body may be assigned dosimetry.
- Note that 500 millirem is also the ALARA action level for whole body dose.

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ALARA & Pregnant Workers

- A sound ALARA program also addresses declared pregnant workers. An individual working with or near radiation sources can voluntarily declare her pregnancy, in writing, to safety representatives.
- This confidential declaration grants the right to monitor the exposure to the worker and fetus during gestation through the use of dosimeters and bioassays. Radiation Safety representatives should be available offers an information session for an employee declaring a pregnancy in order to answer any questions regarding the use of dosimetry.

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ALARA Policy for Pregnant Workers

- The dose limit for a declared pregnant worker is 500 millirem for the entire pregnancy; fetal dosimetry should be provided on a monthly monitoring frequency.
- Declared Pregnant Workers are requested to participate in the bioassay program if they are in an area using unsealed sources of radioactive material.

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ALARA Policy for Pregnant Workers *(Continued…)*

- Workers should submit, in writing, a declaration directly to the Safety representatives to make an official pregnancy declaration.
- A safety team member should schedule a brief meeting to answer any questions.

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Exposure and Dose Minimization

- Decrease work TIME in the vicinity of the radiation source.
- Increase DISTANCE between personnel and radiation sources.
- Use proper SHIELDING to ensure that the dose rate reading does not exceed 2 millirem per hour in an unrestricted area.
- Reduce the total activity used in an experimental protocol.

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Exposure and Dose Minimization *(Continued…)*

- Use gloves and protective equipment when working with unsealed radionuclides.
- Do not consume food or beverages within a laboratory area.
- Use fume hoods for volatile radioactive compounds.
- Use proper contamination control techniques.

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Radiation and Minors

- Workers less than 18 years of age are restricted to 10% of the annual Occupational limits for adult workers.
- Registration and review of minor's working in areas that house or use radioactive materials or x-ray producing devices must be completed and submitted for review, to obtain approval BEFORE any minor begins work with a radiation source.

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Radiation and Minors *(Continued…)*

- Visiting minors cannot work independently with radiation sources.
- Visiting unapproved minors are not allowed to enter lab facilities.

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Resources

- Nuclear Regulatory Agency
- Conference of Radiation Control Program Directors
- Environmental Protection Agency, Radiation Protection
- International Atomic Energy Agency
- US Department of Transportation

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