

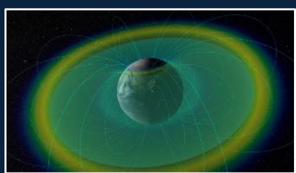

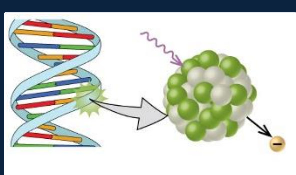



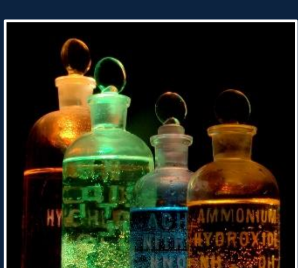

UTSA Laboratory Safety

RADIATION SAFETY PLAN

Laboratory Safety Division

UTSA
Office of the Vice President for
Research, Economic Development,
and Knowledge Enterprise

2021

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REVIEW PAGE

This version of the manual has been reviewed for regulatory compliance and best management practices by the listed individuals and committees and is hereby adopted for use and compliance by all employees at the University of Texas at San Antonio owned or operated facilities pending approval of the Texas Department of State Health Services (TXDSHS).

NAME	TITLE	DATE
Amanda Haley	Biosafety Officer	11-05-2021
Dianna Olukotun	Radiation Safety Officer	11-05-2021
Alexis Godet	Chair, Radiation, and Laser Safety Committee	11-05-2021
Michelle Stevenson	Associate Vice President for Research Integrity	11-05-2021

COMMITTEE

COMMITTEE	REVIEW DATE	APPROVAL DATE
Radiation and Laser Safety Committee	10-01-2021	11-05-2021

This manual took effect as of July 2011 with the approval of the Texas Department of State Health Services of UTSA's license renewal dated June 24, 2010.

This plan was reviewed and approved on 11-05-2021 and replaces the 9/16/2019 plan. Changes to this plan are minor and have been highlighted in "gray" and are summarized below by section:

SECTION	SUMMARY OF CHANGE
	Updated Chair of the RLSC
	Updated RSO and Texas Department of State Health Services
	Formatting change
	Removed "or underwater"

EMERGENCY CONTACTS

ROUTINE OFFICE HOURS (8 am – 5 pm)	
Radiation Safety Officer	210-458-5807
AFTER-HOURS (including weekends)	
Radiation Safety Officer	210-347-5571
UTSA Police	210-458-4911 (cell or outside phone) x4911 (from a campus phone)
LIFE-THREATENING EMERGENCIES (any time)	
UTSA Police	210-458-4911 (cell or outside phone) x4911 (from a campus phone)

ROUTINE CONTACTS

After 5:00 pm and on weekends, UTSA Police will assist in contacting Laboratory Safety Personnel.

UTILITY OUTAGES (Facilities Services) 5277 5277

See Appendix B for **UTSA RADIATION EMERGENCY PROCEDURES** sign. A copy of this sign provided by the RSO **must** be posted in a conspicuous location in each laboratory utilizing radioactive materials.

In the event of a fire, explosion or other serious incident with radioactive or hazardous materials, call the UTSA Police Department as soon as possible (911 on a university phone) and **BE PREPARED TO PROVIDE THE DISPATCHER WITH THE FOLLOWING INFORMATION-BUT DO NOT DELAY AN EMERGENCY CALL TO ACCUMULATE THIS INFORMATION:**

Location of the fire/incident:	(BUILDING & ROOM/LAB NUMBER)
Hazardous materials involved	(RADIOACTIVE MATERIAL/NAME/TYPE)
If medical assistance is needed:	(TYPE OF INJURY & NUMBER INJURED)

INTRODUCTION

OVERVIEW

The University of Texas at San Antonio (UTSA) Radiation Safety Plan contains the current official radiation safety procedures for UTSA and serves as the guidance document for the institution's radiation safety and protection program. The purpose of this plan is to provide information and establish general procedures on the proper use and handling of radioactive materials. Radiation Safety Personnel (RSP) should be consulted for explanations or additional information.

All personnel who work, or are planning to work, with radioactive materials are responsible for knowing and adhering to this plan. It is the users' responsibility to be aware of the hazards associated with the use of radiation and to obey all UTSA policies and State and Federal Regulations concerning radiation doses received by occupationally exposed personnel and the general public. This plan (based on regulations published by the Texas Department of State Health Services – TX DSHS) is a description of practices and regulations regarding the safe handling and use of radioactive materials. All requirements and regulations stated in the plan must be obeyed. Failure to do so is a citable violation and could result in loss of the privilege to use radioactive material for an individual or laboratory. Repeated violations or deviations from the approved procedures may jeopardize any use of ionizing radiation at UTSA.

SCOPE

The UTSA Radiation Safety Plan applies to persons who receive, possess, use, or transfer radioactive materials unless otherwise exempted. The plan applies to all facilities owned, operated or leased by UTSA, to all personnel who work on these facilities, and all equipment owned or leased by UTSA or used within the premises of UTSA. No person may use, manufacture, produce, transport, transfer, receive, acquire, own, possess, process, or dispose of radioactive materials unless that person has a license or exemption from the TX DSHS and approval of the Radiation Safety Officer (RSO) and R&LSC. The RSO will administer all licensing institutionally.

The dose limits in this section do not apply to doses from background radiation. The limits do not include exposures of patients to radiation for the purpose of medical diagnosis or therapy or to voluntary participation in medical research programs. No radiation may be deliberately applied to human beings except by or under the supervision of an individual authorized by and licensed in accordance with Texas' statutes to engage in the healing arts. The Institutional Review Board (IRB) and the TX DSHS must approve medical research programs.

PERIODIC REVIEW

The contents of this plan will be reviewed when relevant sections of the Texas Administrative Code (TAC) on the use of radioactive material are changed or when internal policies mandate a review, but at least every three years.

RESPONSIBILITIES

RADIATION SAFETY OFFICER & RADIATION SAFETY PERSONNEL

1. Reviewing all proposals for use of radioactive material and approving or disapproving them in conjunction with the Radiation & Laser Safety Committee (R&LSC).
2. Inspecting facilities and equipment where or with which radioactive materials are used to ensure radiation safety requirements are met.
3. Performing routine and special surveys in regards to contamination control and dose measurements.
4. Establishing special conditions and requirements as may be necessary for safe and proper use of all radioactive materials.
5. Acting as a consultant in the design of all new facilities using radioactive materials, or constructed to provide protection against radiation exposure.
6. Preparing and disseminating information on radiation safety to the UTSA community.
7. Supervising the UTSA training course on radiation safety.
8. Receiving, storing, processing and delivering radioactive material orders, and maintaining records on all such transactions.
9. Supervising the proper disposal of radioactive waste including effluent releases.
10. Providing personnel monitoring services, including the review and recordkeeping of commercially processed dosimeter reports.
11. Performing or directing all bioassays and environmental surveys as needed.
12. Preparing license applications, amendment applications, and required reports as well as acting as the contact point for all correspondence with State and Federal radiation health regulatory agencies.
13. Investigating unusual radiation exposures, incidents, and accidents and reporting corrective action to the principal investigator, supervisory personnel, and R&LSC.
14. Performing an annual Radiation Protection Program (RPP) audit and reporting the results to the R&LSC.
15. Maintaining calibrations and quality control programs of radiation safety equipment used by RSP.
16. Verifying that proper postings, and signage, are being utilized in areas working with radioactive materials.

PRINCIPAL INVESTIGATORS

1. Completing the required UTSA Radiation Safety Training course available in Bioraft or the equivalent approved by the RSO.

2. Establishing and maintaining specific, written laboratory safety procedures and providing these procedures to the RSO.

3. Ensuring all laboratory personnel complete the UTSA Radiation Safety Training course, receive specific training for the safe use of radioactive materials used in the laboratory and the proper use of radiation detection instruments.

4. Ensuring that laboratory personnel have thorough knowledge of this plan and the regulations pertinent to radioactive material use.

5. Ensuring that all radioactive materials under their control have been properly approved and that all potential hazards are brought to the attention of RSP.

6. Ensuring all appropriate radiation surveys are conducted and all necessary records concerning radioactive materials are maintained.

7. Ensuring all experiments or procedures using 125I, radioactive gases, labeled DNA precursors and/or labeled materials that have radioactive levels of 100 mCi or more are approved in advance by the R&LSC and are performed in a fume hood specifically identified for this purpose.

8. Notifying RSP when new personnel are added or when personnel under their supervision will be leaving the laboratory.

9. Labeling areas and radioactive materials properly.

10. Preventing unauthorized access to radioactive materials by properly securing them within the laboratory at all times.

11. Notifying RSP prior to vacating premises to allow a thorough closeout survey of surfaces and equipment.

12. Providing equipment and shielding in order to maintain doses **As Low As Reasonable Achievable (ALARA)**.

LABORATORY PERSONNEL

1. Following procedures of safe practice contained in this plan and those specific to the laboratory as provided by the PI.

2. Keeping exposures to radiation as low as possible.

3. Wearing appropriate dosimetry, clothing and personal protective equipment when working in the laboratory with radioactive materials.

4. Reporting immediately to the PI and RSP any suspected exposure in excess of permissible limits or any laboratory activities, which could lead to unnecessary exposure.

5. Reporting any contamination to a dosimeter to prevent any cross-contamination of other dosimeters.

6. Immediately report a lost or stolen dosimeter to RSP.

7. Monitoring for and promptly removing radioactive contamination after first having consulted with RSP, if necessary.

8. Reporting accidents or injuries involving radioactive materials, promptly to RSP.

9. Storing and labeling of radioactive materials properly.

10. Packaging and labeling waste for disposal and maintaining records of such disposals.

11. Performing appropriate surveys and maintaining records of results.

12. Contacting RSP at least ONE WEEK before leaving the laboratory or UTSA.

13. Assuring that acquisitions, and transfers of radioactive materials, are made in accordance with the provisions of this plan.

14. Complying with requests from RSP for bioassay. See Bioassays, for specific information.

15. Preventing unauthorized access and possible removal of radioactive materials.

RADIATION AND LASER SAFETY COMMITTEE

The RLSC reviews all work with radioactive materials, X-Ray devices and lasers in research, engineering, and teaching at UTSA. The committee is charged with implementing safety policies, procedures and practices with all systems and provides guidance to the Radiation and Laser Safety Officers in all areas of radiation and laser safety.

1. Formulating policies and procedures and providing the oversight necessary for the control of radioactive materials, radiation-producing machines, and ionizing radiation hazards.

2. Meeting as often as required by regulations or the number of applications submitted, but at least three times per year.

3. Reviewing all proposals for use of radioactive material and approving or disapproving them in conjunction with the RSO.

4. Reviewing complaints of violations of procedures and/or regulations pertaining to radioactive materials at UTSA.

5. Revoking permission to utilize radioactive materials for serious violations of procedures or regulations and reporting to TX DSHS as required.

INSTITUTIONAL BIOSAFETY COMMITTEE (IBC)

The IBC is mandated to be a review body for oversight of all research activities involving the use of hazardous biological materials and recombinant or synthetic nucleic acids, as required by the NIH Guidelines for Research Involving Recombinant or Synthetic Nucleic Acid Molecules and the CDC/NIH Biosafety in Microbiological and Biomedical Laboratories (BMBL) 6th Edition.

CHEMICAL SAFETY COMMITTEE (CSC)

The CSC is charged with promoting safe research with hazardous chemicals in research and teaching laboratories across campus. The committee reviews risk assessments and protocols for working with high hazard chemicals, reviews and contributes to the Chemical Hygiene Plan, advises in incident investigations. The committee is also empowered to recommend additional general safety rules regarding chemical use and establish standard procedures for handling and working with chemicals.

INSTITUTIONAL ANIMAL CARE AND USE COMMITTEE (IACUC)

The IACUC is a research review committee federally mandated by the Animal Welfare Act and the PHS Policy on the Humane Care and Use of Laboratory Animals. Through the expertise of the committee members, which comprise faculty, compliance professionals, safety professionals and community members the IACUC is charged with ensuring that all animal welfare issues associated with research across UTSA. The IACUC may also, in consultation with the CSC, set standards for the use of certain hazardous chemicals and pharmaceuticals in animal research to protect both animals and animal handlers.

INSTITUTIONAL REVIEW BOARD (IRB)

The UTSA Institutional Review Board (IRB) is the university committee that reviews and approves human subject research for the purpose of protecting the rights and welfare of those subjects. The Board is charged with the responsibility to formulate and implement procedures to assure UTSA's compliance with federal, state, and institutional regulations for the safeguarding of the welfare and well-being (physical, mental, social, legal, etc.) of human subjects involved in research projects in which UTSA is engaged or for which UTSA otherwise exercises oversight.

The UTSA IRB operates under a Federal Wide Assurance (FWA) with the Office for Human Research Protections (OHRP) under the Department of Health and Human Services. The IRB advises and educates researchers, staff, and students on research with human subjects and promotes best practices for the ethical conduct of research with these individuals.

RADIATION SAFETY AT A GLANCE

Summary of the minimum requirements to work with radiation.

APPROVALS

Committee	Oversight	Website
RLSC	Use of radiation	RLSC
IBC	rDNA/RNA, Infectious agents, Biohazards	IBC
IACUC	Use of animals	IACUC
IRB	Human subjects	IRB

TRAINING

How	Content	Where
Radiation Safety Training	Radiation Safety	https://utsa.bioraft.com/
Written document	Radiation Safety Plan	Radiation Safety Plan
Written document	Lab specific safety plans and training	Keep documents and records in the lab

OCCUPATIONAL HEALTH

What	Contact Information	Who
Medical Surveillance	Occupational Health: 210-458-5304	Works with/exposed to hazards
Lab Animal Occupational Health Program	Occupational Health: 210-458-5304	Works with/exposed to animals

SAFETY

Tools	When	How
Radiation Monitoring Devices	Processed quarterly	Contact the RSO
Personal Protective Equipment	Per risk assessment	Contact the RSO
Non-exempt, sealed sources	Every 36 months	Contact the RSO

Please contact the Laboratory Safety Division with questions or to request a consultation:
Email: LabSafety@utsa.edu Telephone: 210-458-5807

SAFETY CULTURE

WHAT IS SAFETY CULTURE

Safety culture is a part of organizational culture and is often described by the phrase "the way we do things around here". According to the American Chemical Society, safety culture at an academic institution is a "reflection of the actions, attitudes, and behaviors" demonstrated by the faculty, staff and students concerning safety".

Several high-profile accidents in the research world have led to the realization that ensuring excellence in research requires a strong, positive safety culture throughout the University. This means that safety is viewed as an operational priority, because of the benefits thoughtful, safe procedures and attitudes bring to research.

SAFE RESEARCH AT UTSA

Research and education in science laboratories involves a variety of hazards. It is the University of Texas at San Antonio's (UTSA) policy to protect and promote the health and safety of students and employees as well as the environment. As an educational institution UTSA endeavors to impart a foundation of safety culture that will prepare students to be safe and skilled scientists in academia or industry.

Safety in the laboratory can be achieved only with the exercise of sound judgment and proper use of facilities by informed, responsible individuals.

Safe research starts with recognizing that safety is a fundamental part of the scientific process, adding value by exerting greater control, reducing uncertainty, and increasing the safety and quality of your results or product.

RESEARCH SAFETY EXPECTATIONS

The University expects that all members of our research community integrate safety into their research activities and go beyond minimum compliance. The following elements (Fig 1) help lay the foundation to build and support a safe and productive research environment:

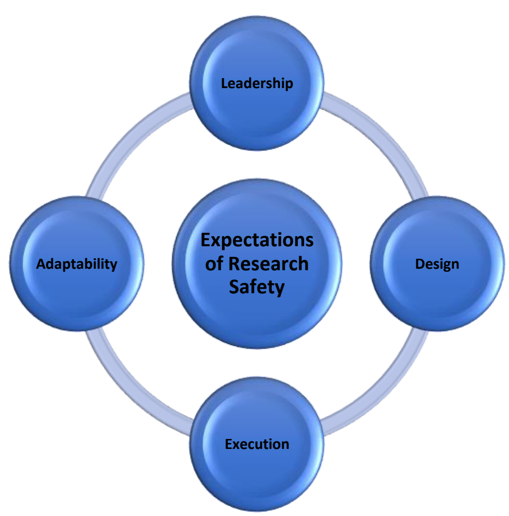


Figure 1. Four Elements of Research Safety

A. Leadership

Lead by example, adhere to the rules, and be willing to speak up if you see unsafe practices. Faculty and other supervisor are urged to include safety on the agenda and incorporate it into their group thinking and practices.

- *Lab members openly discuss safety concerns.*
- *PI/laboratory manager and research group members maintain an environment in which personnel feel free to raise concerns.*
- *Actions confirm safety as a priority that supports and is compatible with good research.*
- *The feedback loop on safety issues (bottom-up and top down) is closed (addressed) at the PI/lab management level.*

B. Design

Take the time to systematically assess risk and plan for the hazards identified. Incorporate safety into laboratory procedures.

- *PI/lab manager understands the risks of the research being conducted, are actively involved in the laboratory safety program, and integrate safety into the laboratory research culture.*

C. Execution

Take action to control your risks. Make sure you have the right protective equipment, engineering controls are working correctly, and researchers are trained to safely perform their work. Principal investigators must enforce the established controls in their lab.

- *PI/lab manager ensures that the personnel, equipment, tools, procedures, and other resources needed to ensure safety in the academic research laboratory are available.*
- *Lab members identify and manage their own safety environment and are receptive and responsive to queries and suggestions about laboratory safety from their lab colleagues.*
- *Lab members conduct their research using protocols and procedures consistent with best safety practices in the lab.*

D. Adaptability

Research is not a static endeavor; managing safety requires ongoing reassessment, feedback, and reinforcement. Encourage reporting by members when identifying and reviewing lessons learned after and using these as teaching opportunities. Involve all lab incidents and near-misses.

- *PI/lab manager evaluates the laboratory safety status themselves and knows what and how to manage changes to enhance safety in the laboratory.*
- *The PI/lab manager and lab group supports a continuous learning environment in which opportunities to improve safety are sought, communicated and implemented.*
- *Safety discussions become part of regular lab meetings; near misses within the lab are reported in a timely manner and safety information is requested by lab members to prevent future mishaps through understanding HOW and WHY.*

A. Delegation

Within a lab responsibility for various activities and training may be delegated, by the PI, to a Laboratory Manager, Senior Researcher or Graduate Student. This can provide valuable experience and ensure there are several individuals assisting less experienced researchers. However, there are often two potential issues associated with this model: (1) the delegation involves responsibility but may have little or no authority or power to enforce practices, and (2) communication between the PI and Manager can be affected by numerous demands on PI time. Preparing for these challenges assists in developing and maintaining a strong and healthy research environment. Some key aspects of effective delegation include matching the correct skill level to the task, having firm goals, and providing solid support.

B. Psychological Safety

Cultivating psychological safety within the culture of a research group provides the basis for a sense of openness and trust. These group-level interactions provide a conducive environment for lab members to feel accepted and respected (Fig 2). When psychological safety is rooted in a lab's culture, the ability to address the potential physical safety and health issues inherent in conducting research is enhanced. With greater safety comes greater control and better science.

Psychological Safety has been shown to provide workplace benefits in different ways, including:

- *Acknowledges limits of current knowledge and improves team innovation*
- *Improves likelihood that an attempted process innovation will be successful*
- *Promotes active listening and learning from all members*
- *Increases capacity to learn from mistakes*

Good lab management and leadership provides a closed loop for Psychological Safety. The two most essential actions identified for this functionality are (1) participatory management and (2) Inclusive management. A clear team structure and strong team relationships are characteristics most conducive to Psychological Safety.

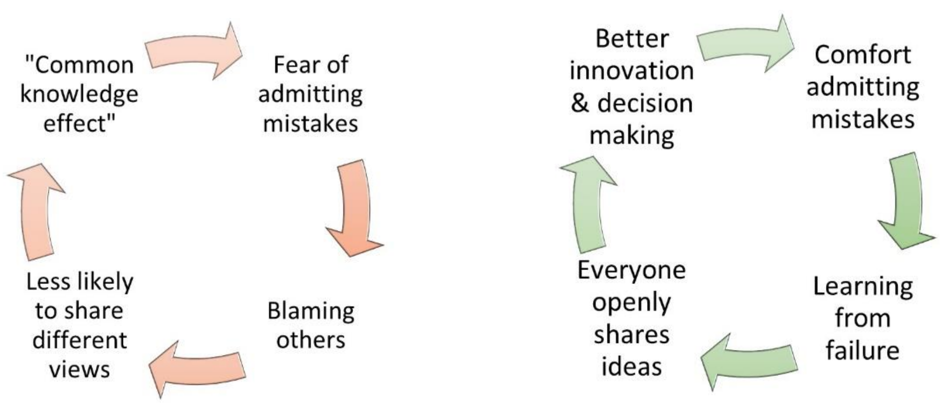


Figure 2. Psychological Danger vs Psychological Safety

RISK ASSESSMENT FOR RESEARCH

Evaluation and assessment of risk is a key part of designing and conducting an experimental protocol. Not only does a thorough risk assessment allow researchers to systematically identify and control hazards, but it also improves the quality of science through more thorough planning, a better understanding of the variables, and by sparking creative and innovative thinking. It allows one to implement tighter controls which reduces uncertainty and increases the safety and quality of your results/product. Failure to consider risk and hazards from the beginning of experimental design can produce delays, roadblocks, and frustration later in the process.

The Risk Assessment process is broken down into four steps:

A. Explore

Determine the scope of your work, beginning with research objective. What question(s) are you trying to answer? Conduct a broad review of the literature. Speak with others who have done similar work. Are the risks different for different approaches?

B. Plan

Outline your procedure/tasks. This may include a deeper dive into specific topics in the literature. Determine hazards associated with each step, and control measures for reducing risk. The Laboratory Safety Division can help with more detailed guidance on how to handle certain hazards.

C. Challenge

What assumptions did you use? Question the importance of each step. Seek advice from others. Ask yourself “what could go wrong?”. Have I missed anything? Consider all possible outcomes, how high is the risk?

D. Assess

Implement a model, prototype, or trial run. Can you perform a dry run to familiarize yourself with equipment and procedures? Can you test your experimental design at a smaller scale or with a less hazardous material? Determine if any design changes are needed. Run your experiment and monitor how your controls perform. Assess as you go and make changes as needed.

HIERACHY OF CONTROLS

Controlling exposure to hazards is a fundamental reference for protecting individuals against hazards. The hierarchy of controls is commonly represented as:

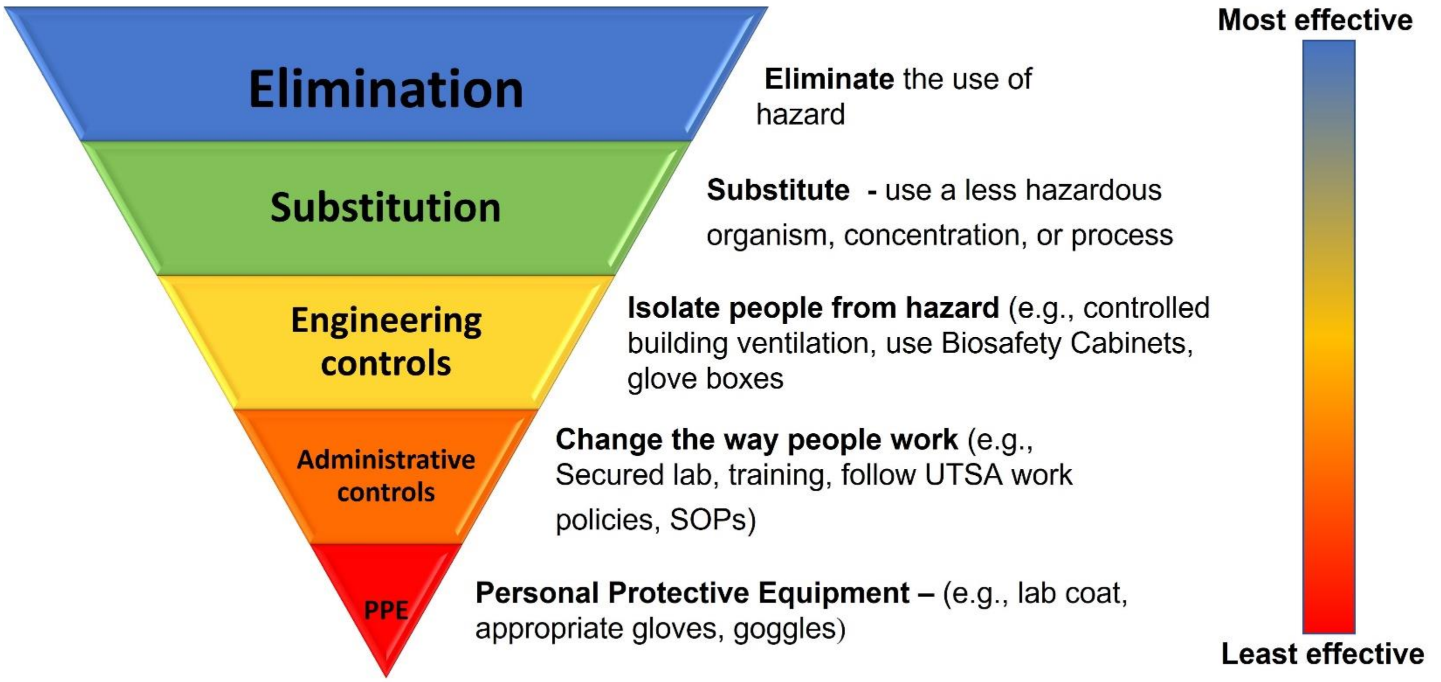


Figure 3. Hierarchy of controls for minimizing hazards.

A. Elimination

While elimination of a hazard is always the safest option it is often not practical in the research environment. Elimination of hazards can be effective when designing new projects but difficult or impossible for existing studies. An example of eliminating a hazard would be autoclaving biological materials therefore removing the biohazard potential.

B. Substitution

Substitution is often an easier option in procedures. Substitution can be common in many biological studies involving infectious agents where a virulent pathogen is replaced with a less virulent, or attenuated strain.

C. Engineering Controls

Engineering controls are a key laboratory feature and are designed to remove the hazard at the source before it can encounter the worker. Engineering controls are highly effective as a safety measure if they are used correctly. Examples of the most used engineering controls in biological facilities are Biosafety Cabinets. These are highly effective at protecting the worker and the samples. However, to be effective the worker must understand how to safely use the equipment and maintain it.

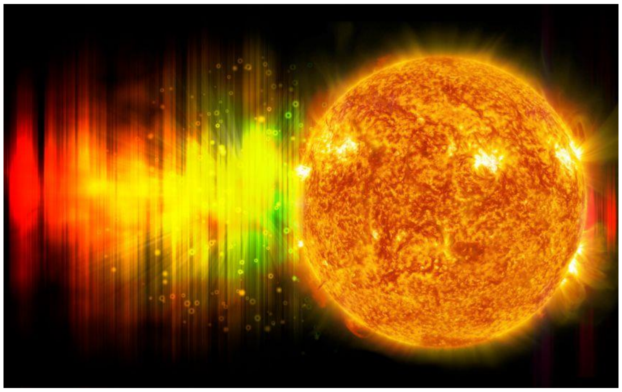
D. Administrative Controls

Administrative controls are used extensively to support safety in facilities. Examples of administrative controls include Standard Operating Procedures (SOPs), Safety Committee protocols, training, and safety plans. The effectiveness of administrative controls is often overlooked as it can be time consuming however, they are an essential component of any strong safety program.

E. Personal Protective Equipment

Personal Protective Equipment (PPE) is generally considered one of the least effective safety controls. PPE does not control the hazard at the source rather protects the worker if all other control methods have failed. As with engineering controls, PPE is only effective if used and maintained correctly.

BIOLOGICAL EFFECTS OF RADIATION



Interaction with ionizing radiation can result in biological damage. This damage can occur at various levels: atomic, molecular, cellular, organ or whole body. The damage is a result of a complex series of chemical events involving charged particles, electrical interactions, ionization or chemical changes.

Damage from radiation interactions can be direct or indirect. Direct interactions with biological molecules can cause damage to molecules, such as DNA, which can result in changes in the cell and possibly cell death. Indirect damage can be the result of reactive free radicals formed by interactions.

The type and amount of damage caused is influenced by the type of radiation, the dose, the dose rate and the radiosensitivity of the cells affected. Cells which are unspecialized, immature cells with a long dividing future and cells that have a high division rate have a greater radiosensitivity.

Biological effects can be somatic or genetic. Somatic effects are those effects seen in the exposed person. Somatic effects can be deterministic or stochastic. Deterministic effects have threshold levels and the severity is proportional to the dose received. Stochastic effects are probabilistic. The probability of occurrence is proportional to the dose received. Early somatic effects occur within hours to weeks after exposure and include nausea, fatigue, erythema, epilation, blood, and intestinal disorders. Late somatic effects occur months or years after exposure and include cataractogenesis, carcinogenesis, and embryologic (birth) defects. Genetic effects are those effects seen in the offspring of exposed organisms. Genetic effects can be dominant or recessive and result from changes in ova or sperm of parents. Genetic effects have only been seen in flies and rodents in laboratory settings. These effects have not been noted to this point in humans.

The most serious biological effect is Acute Radiation Syndrome (ARS), which is caused by an acute high dose exposure greater than 50rem to the whole body. There are three types of ARS: bone marrow syndrome, gastrointestinal syndrome, and central nervous system syndrome.

There are four stages of ARS:

a. The first is the prodromal stage, which includes the classic somatic symptoms within minutes to days of exposure and lasting minutes to several days.
b. The second is a latent stage where the person looks and feels healthy for a few hours to weeks.
c. The third is the manifest illness stage where illness lasts between hours and months and the specific symptoms depend on the type of ARS.
d. The fourth is the recovery or death stage in which the person either recovers or dies.

BASIC PRINCIPLES

It is the responsibility of any person involved in radiation procedures to minimize his or her own exposure to ALARA. The following principles, which apply to whatever form of radiation or radioactive material is present, will help personnel reduce their exposure to levels that are ALARA.

1. Distance

Distance: Radiation exposure is inversely proportional to the square of the distance from the source; thus, maintaining distance from radioactive material offers protection.

2. Time

Time: Since accumulated dose is directly proportional to time exposed, the less time one spends around radioactive material, the less radiation exposure one receives.

3. Shielding

Shielding: Shielding offers a form of protection that requires prior planning and anticipation of safety requirements for given work. Protection offered by shielding depends on the following:

- Initial radiation dose rate without shield.
- Material used for shielding -- the denser the material, the better it is as a shield.
- Thickness of the shield.
- Type and energy of radiation.

CALCULATION OF EXPOSURE AND DOSE RATES

A. Approximate Exposure Rate from Gamma-Emitting Point Source

mR/hr at 1 foot _~ 6 CEn
Where: C = activity in millicuries
E = gamma-ray energy in MeV
n = percent abundance for that specific energy

B. Exposure Rate from Gamma Point Source

mR/hr = 10^3 N Γ d^{-2}
Where: N = activity of source in millicuries
Γ = gamma dose rate constant for that nuclide in R/hr-mCi at 1cm (see Appendix C)
d = distance from source in centimeters

C. Approximate Dose Rate from a Beta Point Source

mrads/hr = 3.1 x 10^5 N d^{-2}
Where: N = the activity of the source in millicuries
d = distance from the source in centimeters

Notes on Approximate Dose Rate from a Beta Point Source

1. The maximum energy of the beta particles must be 0.5 MeV.

2. **d** must be small with respect to the maximum range of the beta particles in air; otherwise, there will be absorption. The dose rate thus derived will be conservatively high from the radiation protection standpoint.

D. Relationship Between Exposure Rate and Distance from Source

$I_2 = I_1 [(d_1)^2/(d_2)^2]$

Where: I_2 = exposure (dose) rate at distance d_2

I_1 = exposure (dose) rate at distance d_1

(The distances must be in the same units)

E. Radioactive Decay

$A = A_o e^{-kt}$

From which, $\ln(A) = \ln(A_o)^{-kt}$, $\ln(A/A_o) = \ln(e^{-kt})$

Where: A = activity remaining after the time interval t

A_o = activity at some original time

e = base of natural logarithm system = 2.7183

t = the elapsed time

k = the decay constant for a particular radionuclide

k = ln2/t1/2

ln2 = 0.693

t1/2 = the physical half-life of the radionuclide

NOTE: t1/2 and t must be in the same units.

SHIELDING OF GAMMA RADIATION SOURCES

$I = BI_o e^{-\mu x}$

Where: B = build-up factor (dependent upon composition of shielding, the energy of the gamma radiations and the thickness of shield). See Radiological Health Handbook, 1970 Edition, PHS Publication No. 2016.

I_o = the original exposure rate

e = base of natural logarithm system = 2.7183

x = the shield thickness

μ = the linear absorption coefficient (reciprocal units of the shield thickness)

NOTE: $\mu = (\mu a/\rho)\rho$

Where: $\mu a/\rho$ is the mass absorption coefficient.

See NSRDS-NBS Report No. 29 for values of $\mu a/\rho$

ρ = the density of the shielding or

$\mu = \ln 2/x^{1/2}$

Where: ln2 = 0.693

$x^{1/2}$ = the amount of shielding that will reduce the radiation intensity by half.

RADIATION SAFETY PROCEDURES

RADIOACTIVE MATERIAL SAFETY – TARGET PERSONNEL

The safety guidance within this plan is designed to protect four groups of individuals:

A. Laboratory Personnel

The people who work on a day-to-day basis in a laboratory that utilizes radioactive materials, whether or not they actually handle the sources directly.

B. Faculty and Staff

The people who are responsible for the supervision of laboratory personnel who handle radioactive materials and the University employees that must enter the laboratory containing radioactive materials for maintenance and/or repair of facilities or other duties.

C. Students

The people who are being trained in the laboratory setting, whether or not their training/education program directly deals with the handling of radioactive materials.

D. Other Persons

The people who are internal or external to UTSA, who, without their knowledge or permission, may be exposed to radiation. This group may include facilities, housekeepers, external contractors, and UTSA security staff.

RADIATION SURVEY PROCEDURES

Handling of radioactive materials in the form of gases, liquids and/or solids in the laboratory necessitates both radiation surveys and contamination surveys to prevent unnecessary radiation exposure. Furthermore, these surveys are required to prevent the spread of radioactive contamination throughout UTSA. Radiation surveys are performed by using a radiation survey meter. Contamination surveys are performed by taking swipe samples from areas where work with radioactive material is being carried out or where contamination is suspected or might occur. See Radiation Surveys and Decontamination for frequency and methods for performing surveys and decontamination.

A. Restricted areas

A restricted area is an area, access to which is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to ionizing radiation or radioactive materials. Restricted area does not include areas used as residential quarters, but separate rooms in a residential building may be set apart as a restricted area.

When an area contains radiation exposure levels >2 mrem/hr (>20 µSv/hr) or contains radioactive material exceeding 10 times the quantity specified per isotope in Appendix C of 10 CFR Part 20 it shall be designated a "restricted area"; it shall be posted, and access shall be controlled by the responsible Authorized User to ensure that:

- access is limited to authorized personnel equipped with appropriate personal dosimetry;
- visitors are escorted by an authorized individual, are equipped with personal dosimetry; and
- the total effective dose equivalent to any visitor from licensed operations does not exceed 100 mrem (1 mSv) in a year.

More than one of the sub-classifications defined below may be applicable to a restricted area.

RADIATION AREA means an area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 5 mrem (50 µSv) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

HIGH RADIATION AREA means an area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 100 mrem (1 mSv) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

AIRBORNE RADIOACTIVITY AREA means a room, enclosure or area in which airborne radioactive materials, composed wholly or partly of licensed material, exists in concentrations:

- In excess of the derived air concentrations (DACs) specified in Appendix B to 20 CFR 20.001-20.2401, or
- To such a degree that an individual present in the area without respiratory protective equipment could exceed, during the hours an individual is present in a week, an intake of 0.6 percent of the annual limit on intake (ALI) or 12 DAC-hours.

No practice or procedure having the potential to create a high radiation area or airborne radioactivity area shall be performed at UTSA without the express consent of the RLSC.

B. Unrestricted areas

Unrestricted area means an area, access to which is neither limited nor controlled by the licensee.

No member of the public shall receive a dose exceeding 2 mrem (20 µSv in any one hour, nor shall radioactive material be used or stored in an unrestricted area in quantities that (per isotope) exceed those specified in Appendix C of 10 CFR Part 20. Licensed materials stored in an unrestricted area shall be secured from unauthorized removal or access. Constant surveillance shall be maintained over any licensed material in use (i.e., not in storage) in an unrestricted area.

UNRESTRICTED AREAS	RESTRICTED AREAS
Personnel cannot exceed dosage levels of 100 mR/yr or 2 mR/hr	Radiation levels should be as low as achievable with adequate shielding as assessed by RSP.

Table 1. Acceptable radiation dosages in unrestricted and restricted areas.

Wipe samples indicating 1000 disintegrations per minute (dpm)/100 cm^2 must be cleaned until the contamination is removed. Since this level is sometimes difficult to establish, whenever a wipe sample shows a detectable amount of activity above background, the area should be cleaned.

PERSONNEL MONITORING – DOSIMETRY

Use of a dosimetry badge requires consideration of the properties of the radiation, the level of potential exposure, and the complexity of the application. Commercial badge services make it technically feasible to obtain reliable readings at exposure levels down to 1 millirem. Although exposure at this low level is not very significant, monitoring may be provided to help the user practice exposure ALARA (as low as reasonably achievable) in routine operations or document exposure during an accident. Also, to be noted, alpha, low-energy beta radiations (e.g., ^{3}H and ^{14}C), and neutrons of certain energies are not detected by film, Luxel, or TLD badges. Any person likely to receive 10% or more of the applicable annual allowable dose limit is required to utilize a dosimetry badge or other appropriate monitoring device. RSP will determine if a person is likely to receive this dose level.

In order to obtain meaningful information from the use of a badge, the following guidelines must be observed:

A. Adopting the Appropriate Badge:

1. RSP will determine the appropriate type of badge and the change frequency for the conditions to be encountered.

2. Types of dosimeters used to monitor whole-body exposure include beta-gamma x-ray, and neutron beta-gamma x-ray dosimeters. Thermoluminescent (TLD) dosimeters are used for monitoring exposure to hands or wrists. Luxel or TLD dosimeters are required for persons who routinely handle millicurie quantities of gamma emitters or highly energetic beta emitters such as 32P. Both types of dosimeters are processed quarterly.

CAUTION

A badge or dosimeter should be processed immediately whenever an unusual or excessive exposure is suspected. Call the RSO if such circumstances arise.

B. Proper Use of the Badge

1. Only the person who is assigned a badge should wear it. Do not loan a badge or use it for monitoring an area.

2. It is essential to monitor the portion of the body receiving the highest exposure.

3. The dosimetry badge is used to measure occupational exposure to radiation. It must be worn whenever working with radioactive materials or when in an area where exposure might occur at UTSA. The badge must not be worn away from UTSA, especially when receiving medical radiation exposure, such as diagnostic x-rays or nuclear medical treatments.

C. Declared Pregnant Worker

For a pregnant worker to be monitored for fetal dose limits, limits are mandated by Federal and State regulations, pregnancy needs to be declared in writing to the RSO. This declaration is voluntary and no worker is required to declare a pregnancy. Standard personal dose limits will apply if no written declaration has been made. The pregnant workers declaration Form can be found in Appendix D of this plan and on the laboratory safety division website. The declaration can be rescinded at any time by the worker.

Declared pregnant workers will be provided with an additional dosimetry badge to be worn on the abdomen, this badge is used to monitor the fetal dose. Fetal dose limits are 500 mrem per term and 50 mrem per month.

Each individual shall be responsible for ensuring that his/her occupational exposure is maintained ALARA. Each Authorized User shall control operations so that no individual working in a controlled or restricted area receives from sources in the possession of UTSA an occupational dose equivalent that exceeds the ALARA goals established herein. Should any UTSA employee receive a dose exceeding an ALARA goal, the RSO will perform an investigation and document relevant findings.

ALARA

Not withstanding the prescribed limits, operations shall be conducted so as to maintain radiation exposures as low as is reasonably achievable (ALARA)

D. Exposure Limits for Radiation Workers

The maximum permissible dose limits as per 25 TAC §289.202 are specified in the following list:

1. Annual Limits for Adults

    a. The total effective dose equivalent is equal to 5 rem or;

    b. The sum of the deep dose equivalent and the committed dose equivalent to any individual organ or tissue other than the lens of the eye being equal to 50 rem

    c. A shallow dose equivalent to the skin or to any extremity of 50 rem

    d. An eye dose equivalent of 15 rem

2. Additional recommended limits for special situations include:

    a. Fetus during entire pregnancy not to exceed: 0.5 rem

b. Students under 18 years old are not exceeding 10% of the annual adult dose limits.

ORGAN	10 CFR 20 ANNUAL LIMIT mrem (mSv)
Total Effective Dose Equivalent: • **For an adult individual** • **For a minor** • **For a declared pregnant woman**	 50,000 (50) 500 (5) 500 (5)
Eye dose equivalent	15,000 (150)
Shallow dose equivalent to the skin or to any extremity	50,000 (500)

Table 2. Summary of occupational dose limits.

LEAK TESTS OF SEALED SOURCES

All nonexempt, licensed, sealed sources will be tested every thirty-six months (or more frequently if requested by the user) by a firm licensed by the Texas Department of State Health Services to measure for leakage. All generally licensed sealed sources will be tested per the manufacturer's recommendations. Sealed sources must be shown to exhibit removable levels of less than 0.005 µCi. Samples will be taken by RSP and mailed to the firm for analysis.

BIOASSAYS

RSP will perform all bioassays in accordance with the conditions of UTSA's license, or when ingestion or inhalation of radioactive materials is suspected. Any significant, positive results will initiate an investigation of the working conditions and procedures used in working with radioactive materials. Follow-up bioassays will be performed as required by the situation. The reports of the bioassay become part of the individual's exposure history and are kept on file.

Persons handling 100 mCi of tritiated (^3H) material will submit a urine sample per RSP instructions within twenty-four hours to determine tritium levels. Persons handling unbound radioactive iodine are required to contact RSP regarding the thyroid bioassay program. A baseline level must be obtained prior to initiation of work with unbound iodine. Periodic checks will be performed to determine any uptake and compared to established action levels. Action levels in both cases will result in investigations and follow-up actions and reporting.

RADIATION SAFETY TRAINING

INSTITUTIONAL SAFETY TRAINING COURSE

A formal Radiation Safety Training Course is available for all personnel handling radioactive materials through BioRAFT. This training can also be delivered in person on request, please contact the RSO to schedule this course in person. This course must be completed by all personnel prior to working in a laboratory that uses or stores radioactive material unless an exception for prior training has been granted by the RSO. The course covers:

1. The fundamentals of radiation safety including the characteristics of radiation, units of radiation dose (rem) and activity (curie), significance of radiation dose (radiation protection standards and biological effects of radiation), levels of radiation from sources of radiation, methods of controlling radiation dose (time, distance and shielding), radiation safety practices (prevention of contamination and methods of decontamination), and discussion of internal exposure pathways.

2. Radiation detection instrumentation to be used, including radiation survey instruments and their operation, calibration and limitations. Survey techniques and individual monitoring devices to be used by laboratory workers using radioactive materials.

3. Equipment to be used including handling equipment and remote handling tools, sources of radiation, storage, control, disposal, and transport of equipment and sources of radiation, operation, and control of equipment and maintenance of equipment.

4. The requirements of pertinent federal and state regulations.

5. UTSA's written operating, safety and emergency procedures.

6. UTSA's record-keeping procedures.

LABORATORY SPECIFIC TRAINING

All PI's are responsible for training their staff, students and other personnel on laboratory specific safety requirements, standard operating procedures (SOPs), equipment use and emergency response. This training must be documented and records available to the RSO on request. The RSO can assist PI's with developing laboratory specific training upon request.

POLICIES AND PROCEDURES

AUTHORIZATION TO USE RADIOACTIVE MATERIALS

Approval to use radioactive materials must be obtained prior to purchase by following the steps detailed below:

1. A memorandum must be sent to the RSO/R&LSC covering the following items in the order listed:

    a. Name and title of applicant (project supervisor).

    b. Curriculum Vitae

    c. Building and room. Include a SKETCH (building drawings can be obtained from Facilities) of the room showing facilities to be used.

    d. Names and titles of technically trained faculty, staff, and students participating in the project. List the completion date of the UTSA Radiation Safety Training course or approved equivalent for each person.

    e. If material is to be used in classwork, indicate whether persons under 18 years of age may be present and the anticipated exposure rate. Arrange for the class to take the UTSA Radiation Safety Training course.

    f. The radioisotope(s), chemical form and maximum quantity to be used per experiment, frequency of experiments, maximum quantity to be obtained per order, maximum to be possessed at any time and an estimate of potential exposures to gamma and beta emitters.

    g. Proposed use. Briefly describe the procedures to be followed in sufficient detail to permit a radiation safety evaluation to be made by the RSO and R&LSC. **Allow sufficient time for this review**.

    h. List protective equipment (e.g., fume hoods, shielding, etc.) to be used. Include plans for handling and storing radioactive materials, care of animals exposed to radioactive materials, disposal of radioactive wastes, etc. List survey instruments that are available for surveys by laboratory personnel. Each laboratory is required to have suitable monitoring instrumentation for the detection of the radiation.

    i. If a fume hood is to be utilized, a detailed protocol is required and must include in addition to the information listed above, the procedure for monitoring the effluent (and/or containment) and an estimated minimum and maximum effluent given off during the experiment.

    j. If this is a first experiment, give a brief but explicit description of the previous experience and training of the persons listed in number four. Particularly, emphasize experience with and knowledge of radiation.

k. Enumerate safety considerations that are involved and the measures that will be taken to implement radiation safety. Indicate how possible personnel and facility contamination will be assessed.

NOTE

A specially designated fume hood must be utilized for experiments involving ^{125}I, radioactive gases, labeled DNA precursors and/or labeled materials in excess of 100 mCi.

Approval for a project generally will be for a period of one to three years. At the end of this period, the project supervisor will have to update the application. The review process is summarized below in Figure 4

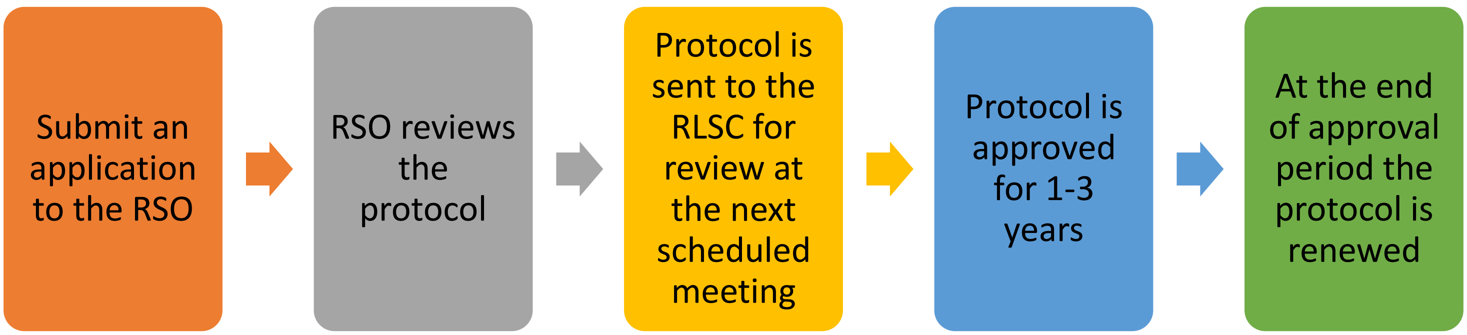


Figure 4. Summary of radiation safety protocol review process.

NOTE

The protocol information is not only required for internal UTSA review, but also for the licensing division of the TX DSHS Radiation Control Program and is forwarded to them for addition to the license.

No one at UTSA may order radioactive materials unless they have been approved and placed on UTSA's Radiation License.

ACQUISITION OF RADIOACTIVE MATERIALS

A. Purchase of Radioactive Materials

Radioactive materials may be ordered only by persons who have obtained official authorization to use such materials. Official authorization involves listing on the Radiation License for UTSA after approval by TX DSHS and the RLSC.

All purchase requests for radioactive materials must be submitted to the RSO for approval. Providing the amount of material requested does not exceed the authorized inventory level for UTSA and the radioisotope is approved on the Radiation License, the purchase request will be approved by RSO. Without this approval, the Purchasing and Accounting departments will not process the order. To ensure orders are processed in a timely manner, call RSP or send an email indicating that an order has been submitted for approval.

B. Receipt of Radioactive Materials

When radioactive materials are ordered it is important to maintain chain of custody. The following steps are in place to ensure that radioactive materials, arriving at UTSA, remain safe and secure.

1. Inspection by Radiation Safety Personnel

After receipt of radioactive materials by Central Receiving Warehouse (CRW) personnel, RSP will be notified. The packing slip of all packages received will be examined to determine that the correct radioisotope, chemical form, and amount of material has been received. All packages will be examined for signs of damage.

All packages will be surveyed for external radiation levels with a hand-held meter equipped with a thin end-window G-M probe or a NaI crystal detector. Radiation levels must not exceed 200 millirems/hr at the surface or 10 millirem at 1 meter [25 TAC §289.202(ee)].

For Yellow II and Yellow III labeled packages, the dose rate expected at 1 meter from the package surface is that indicated by the “transport index” on the label. The dose rate at the surface should not exceed 200 millirems/hr.

The dose rate for “White I” labeled packages should not exceed 0.5 millirems/hr at the surface. Since a survey meter will not readily detect low levels of removable contamination from weak beta or gamma emitters, all packages will also be wipe tested at various locations over a total of ~300 cm^2 for removable external contamination. These wipe tests will be analyzed by a liquid scintillation counter.

When the package is determined to be acceptable, RSP will deliver the package to the authorized use location. The user will be responsible for inspecting the contents inside the package and verifying the actual contents. This process is summarized in Figure

For packages that are damaged and contaminated or exceed the limits on external radiation or removable contamination, the package will be held for return and the final delivery carrier and the TX DSHS will be immediately notified by telephone and in writing (e.g., facsimile).

Figure 5. Summary of radiation package receipt and delivery.

2. Opening and inspection of the package by the end user

When a new package arrives, it should be handled with caution until the integrity of the contents has been verified. Personal Protective Equipment (PPE), including gloves, must be worn.

Put on gloves to prevent hand contamination. Inspect the package for signs of visible damage at the point of opening and notify RSP if damage is observed at any time during opening and no further handling is to occur. If external radiation levels are greater than expected, stop and notify the RSP.

Remove and read the Safety Data Sheet and the copy of the packing slip.

Open the inner package and verify that the contents agree with the packing slip and the material ordered. Check the integrity of the final inner container. Look for broken seals or vials, loss of liquid, condensation, or discoloration of the packing material. If anything appears damaged or out of place, stop and notify RSP.

Perform a wipe test on the final inner container. Until the results of the wipe test are obtained, assume that the materials received may be contaminated and take precautions to prevent the potential spread of contamination.

Monitor the packing material and the empty packages with a survey meter before discarding. If contamination is discovered for any packing material, it must be treated as radioactive waste.

If the packaging is not contaminated, remove or destroy all radiation labels or indicators prior to discarding in the trash. **DO NOT DISCARD NON-RADIOACTIVE MATERIALS IN RADIOACTIVE WASTE**.

Record the amount and type of radioisotope received and begin a log of use for the material in that package (Safety Data Sheet in the Radiation Log notebook along with the wipe test results).

- Put on PPE, including gloves and a laboratory coat.
- Inspect the package for signs of damage. If there is damage or external radiation levels are high contact the RSO immediately.
- Inspect the inner packaging for damage. Verify that the contents match the information on the packing slip. Report any damage to the RSO.
- Perform a wipe test on the final inner container.
- If the inner packaging is contaminated discard packing material as radioactive waste.
- If the inner packaging is not contaminated remove/destroy all radiation labels and discard in the trash
- Record the package contents in the Radiation Log and file the SDS with the Log.

Figure 6. Summary of radiation package receipt steps for the end user.

C. Acquisition of "No Charge" Radioactive Materials

The RSO must be notified and give approval prior to the acquisition of "no-charge" (free) radioactive materials. Only those persons with official authorization may obtain such materials if there is an immediate need and the material will not become a disposal problem.

D. General License Materials

For research purposes, small quantities of certain isotopes can be purchased without a specific license. These General License materials are subject to similar requirements for record-keeping, contamination control, and waste disposal accounting. No General License Material shall be acquired or disposed of without the RSO's approval. Contact RSO to verify whether your radioactive isotope of interest requires a license.

ACCOUNTABILITY FOR RADIOACTIVE MATERIALS

A. Locations of Use

Radioactive materials may only be used in those facilities that have been approved and placed on UTSA's Radiation License. Investigators wishing to expand their areas or move into new areas must submit an application that includes a description of the area (fixtures, storage, etc.) and any other required features along with a floor plan with usage and storage areas marked. Approval is specific to a particular user for a particular radioactive material and purpose.

B. Transfer of Radioactive Materials

There are circumstances that may arise which make it desirable to transfer radioactive materials from one laboratory to another. Since the RSP and RLSC must be informed of the status of radiation use in all campus areas at all times, the following general procedures must be observed.

1. On-Campus Transfer

The transferor must inform RSO to assure that the recipient has been authorized to use the specific radioactive material being transferred. Submit the following information to RSP and RLSC for advance approval. Transfer, especially between floors or buildings, must be approved in advance by RSP. The following information must be provided for approval:

1. Radioactive material to be transferred
2. Chemical and physical form
3. Activity (in microcuries)
4. Name and department of transferor
5. Name and department of recipient
6. Current location and transfer location

2. Off-Campus Transfer

Consult RSP for the procedure to be followed. It is necessary to arrange in advance receipt of the material at its destination and proper transportation requirements must be met depending upon the radioactive material to be shipped. RSP will coordinate with CRW to prepare materials for commercial transportation. Private transportation is not allowed and might cause serious liability. Proper shipping training with documentation is required for anyone shipping radioactive materials.

Radioactive materials training for shipment or transport needs to be completed within 90 days after employment or a change in job function and every three years thereafter in accordance with 49 CFR Part 172: Subpart H.

C. Disposal of Radioactive Wastes

All potentially contaminated materials should be considered radioactive unless a survey of the material reveals no contamination detectable with instrumentation of adequate sensitivity.

All radioactive waste must be placed in appropriate waste containers approved by RSP. Liquid waste must be contained in tightly-capped plastic carboys which are only opened when actively adding waste. Attempts should be made to separate aqueous and organic radioactive wastes. The generation of mixed waste containing hazardous chemicals and radioactive material must be approved in advance by RSP and R&LSC. The generation of radioactive solid waste containing hazardous chemicals should be avoided entirely as disposal may be extremely expensive or impossible. No glass bottles are permitted for disposal of liquid wastes unless authorized by RSP. Individual radioactive labels are to be removed or obliterated from waste material upon discard into labeled waste containers so that material later disposed of as exempt or decayed will not contain false radioactive warnings. Label all waste containers "Caution -- Radioactive Material" with the trefoil radiation symbol and record the radioisotope, quantity in microcuries, and date. Radioactive waste must be segregated by radioisotope. Prior permission of RSP is needed to generate waste containing more than one radioisotope.

In order to dispose of radioactive waste, the PI or representative should contact RSP for pickup of the materials. Disposal of radioactive wastes without prior contact is not permitted. No one may enter the waste disposal room unless accompanied by RSP. The authorized user is responsible for completing a Radioactive Materials Disposal Form and providing it to RSP at the time of waste pickup.

Scintillation vials are to be disposed of boxed upright. For radioisotopes other than ^{14}C or ^{3}H, separate vials containing radioisotope from wipe test vials containing little or no radioactivity.

NOTE:

No radioactive waste is to be released into the sewer system by laboratory personnel and no radioactive waste is to be incinerated.

Empty laboratory containers must be thoroughly rinsed several times into liquid waste before washing. The efficacy of the rinsing protocol should be documented initially by scintillation counting the final rinse.

D. Radiation Log Notebook

Each laboratory must maintain a laboratory notebook in which pertinent records are permanently filed and readily available. This notebook must be accessible to all persons who work with radioactive materials under the project. The notebook must include, but is not limited to, the following records:

1. Correspondence with RSP and RLSC.

2. Receipt, utilization, and disposal of each radioactive material, shipment, etc. It is essential that these records account for the difference between radioisotopes on hand and those received.

3. An inventory of radioactive materials on hand in the laboratory.

4. Instrument surveys and results of wipe tests for removable contamination --specify the date, the person making the survey, the instrument used, including serial number, model number and the location and levels of radiation and contamination encountered. Details of any contamination cleanup and after cleanup surveys. It is important that a statement regarding the average exposure reading encountered in work areas be included in the record even when this value is essentially background. Causes of high survey readings should be determined (with the assistance of RSP if necessary) documented and eliminated whenever possible.

5. Results of any sealed-source leak tests pertaining to any sources in the laboratory.

6. Additional miscellaneous entries in the notebook should include the addition or deletion of personnel from the project staff, significant instruction or information programs carried out for or attended by students or technical assistants, and accidents or instances of contamination together with a description of corrective actions.

Inventory control forms must be filed with RSP whenever requested.

RSP must be notified immediately whenever radioactive materials have been lost or misplaced.

RADIATION SURVEYS

Good laboratory practice dictates that radiation surveys be made during and after experiments and routinely thereafter to ensure that radioactive materials are adequately shielded and that contamination is controlled.

A. Instruments

Portable radiation detection instruments are commonly used to make radiation surveys and evaluate levels of contamination (except for ^{3}H contamination). Each laboratory that uses radioactive materials is responsible for possessing or having access to the radiation detection instrument which is appropriate for the radioactive material with which it works. RSP can assist in choosing the correct detector. Examples of common detectors include Geiger Mueller counters and ion chamber counters. Liquid scintillation counters are used to measure wipe surveys.

The manufacturer’s instruction for use should be followed for detectors. RSP can assist if questions arise on proper operation. Detectors must be calibrated at least annually and whenever major changes/repairs occur. An un-calibrated detector should never be relied upon for surveys as contamination might be undetected and lead to unnecessary exposures.

B. Wipe Surveys

An effective method for surveying for removable contamination -- the only effective method of surveying tritium contamination -- is to take wipes in work areas, on floors, etc., using filter paper or cotton swabs. A series of wipes should be taken from those surfaces where contamination is likely or where radiation levels are high. This can include but is not limited to, incoming packages, areas where solutions are prepared, pipetting is performed, organic synthesis undertaken, etc. The wipes should be numbered, labeled, and located on a sketch of the areas being examined. The wipes are rubbed over a surface area of ~100 square centimeters. Count the wipes in a suitable detection system (for ^{3}H, a liquid scintillation counter is usually the only suitable counter). The resulting counts give an indication of the levels of contamination. In keeping with the ALARA philosophy, detectable contamination should be promptly removed. If serious contamination, e.g., 50,000 dpm on a wipe, is found, call RSP for assistance.

Keep a record of results of surveys performed by the laboratory personnel in the laboratory notebook. RSP makes periodic surveys of all laboratories where radioactive materials are used and issues written reports. Special surveys may be requested when it is believed necessary.

C. Surveys Required on Transfer

Equipment used with radioactive materials must be surveyed before being transferred between laboratories, being transferred to surplus, or transferred for repair. Radioactive warning tags indicating radioisotope used should not be removed from equipment without wipe surveys documenting lack of contamination. For transfers to non-radioisotope using laboratories, to surplus, or off-campus, RSP should perform the surveys.

D. Leak Tests of Sealed Sources

All nonexempt, licensed, sealed sources will be tested at three-year intervals or as otherwise required. Testing will be conducted by a firm approved to do so by TX DSHS. Examinations are conducted to ensure that sources do not exhibit leakage in amounts greater than 0.005 µCi. If a suspected problem occurs with a sealed source, contact RSP and arrangements will be made to test the source immediately. All leaking sources will be properly disposed of by RSP.

E. Frequency of Surveys

The frequency of surveys depends upon the amount and type of radioactive material used. Listed below are examples that may be useful in determining how often to perform surveys. The greater the workload, the more often the surveys should be performed.

Low-Level Areas – At least once a month - Areas such as where in vitro tests are performed, samples analyzed, etc. (samples usually less than 100 microcuries each).

Medium-Level Areas – At least once a week - Areas where 100 microcurie to millicurie amounts of material are handled.

High-Level Areas – At least once a day - Areas used for storage of active solutions, preparation of materials, fume hoods, etc. (usually tens of millicurie amounts).

F. Acceptable Limits for Radioactive Contamination

Acceptable limits of contamination shall be as follows

1. In controlled areas specifically designated for use of radioactive material by users only and not frequented by members of the general public (non-users of radioactivity), the continuous dose rate outside of shielding shall be no greater than 0.2 mrem/hr and removable contamination on designated work area surfaces shall not exceed 1000 dpm/100 cm2 (beta-gamma) or 100 dpm/100 cm2 (alpha)

2. In uncontrolled areas accessible to the general public (non-users of radioactivity) and not specifically designated for radiation use, radiation levels shall not exceed 2 millirem in any one hour and 100 millirem

per year. Both limits must be observed and documented. Removable contamination will not exceed 100 dpm/100 cm^2.

3. In both cases, calibrated instruments with known efficiency for the radiation being detected must be used.

STANDARD METHODS FOR REDUCING EXPOSURE AND CONTAMINATION

A. Storage of Radioactive Materials

1. Store all radioactive material in a place to minimize exposure.
2. Use adequate shielding -- exposure rate should not exceed 2mR/hr at 30 cm from the shield. Include areas behind the shield, above and below when assessing exposure rates. Ensure a benchtop will support the weight of a shield and that shielding materials are secured so that they will not fall.
3. Use a pan and/ or absorbent pad when using liquids to catch spills.
4. Clearly identify each item in storage as being radioactive by using the appropriate labeling.
5. Survey area periodically using an appropriate method.
6. Post storage areas with proper signage or labels.
7. Do not store food in areas (including refrigerators) where radioactive materials are stored.
8. Locate appropriate handling tools and supplies conveniently.
9. Store radioactive liquids in unbreakable containers or in secondary containers to prevent or contain spillage.
10. Shield radioactive wastes awaiting pickup so that radiation levels at 30 cm do not exceed 2mR/hr.

B. Work Areas

1. Use absorbent pads or pans to cover work areas. Small, easily spilled containers need a stable work surface to prevent spills.
2. Good housekeeping is required where radioactive materials are used. Clean contaminated items as soon as possible. Change bench covering frequently enough to prevent external exposure from spots of contamination and to reduce airborne contamination from dried spills.
3. Provide adequate shielding to ensure radiation exposure rate is less than 2mR/hr at 30 cm from shields. Survey periodically using appropriate methods. Make sure that a bench will support the required shielding and that the shield is secured so that it will not fall.
4. Do not keep foods or beverages where radioactive materials are present. Smoking, eating and drinking in laboratories is prohibited.

C. Handling

1. Wear appropriate personal protective equipment such as gloves, safety goggles, and a laboratory coat when handling unsealed radioactive material. If there is a dosimetry badge and/or ring assigned to user, these must be worn every time radioactive material is handled. In some instances, leaded aprons or other garments may be necessary or useful. Wear shoes that completely cover the feet.

2. Use remote or hand-controlled pipettes. Mouth pipetting with radioactive materials is prohibited.

3. Use appropriate containment, e.g., fume hoods or glove boxes, for handling radioactive materials that may become airborne, such as dust or vapors. Where radioactive iodine vapors are present, always use a fume hood that has a minimum average face velocity of 100 ± 20 feet per minute at the sash opening.

4. Never work with radioactive materials with open cuts on the skin, which may become contaminated.

5. Do not eat, drink, or smoke in areas where radioactive materials are used or stored.

6. Be informed; know the mechanical, chemical and radiation hazards of the materials and operations that are to be performed. Frequently, it is useful to try a dry-run experiment to see if a radioactive experiment is feasible.

LABORATORY COATS

Did you know that laboratory coats are available, free, to all researchers from vending machines at four locations on campus: AET, BSE, SEB and MBT?

Contact the Laboratory Safety Division for your vending machine card.

D. Posting and Labeling Requirements

In certain instances, signs or labels are required for specific levels of radiation and radioactivity. Consult RSP for assistance in posting or otherwise controlling areas where radiation dose rates exceed 100mR/hr, or where radioactive materials may be airborne. The following are some of the general requirements for signs and labels. Signs are usually available from RSP.

1. "Radiation Area - Authorized Personnel Only"

This sign is used in an area where radiation levels could result in an individual receiving a dose equivalent in excess of 0.005 rem (0.05 millisievert) in 1 hour at 30 centimeters from the source of radiation or from any surface that the radiation penetrates.

2. "Caution -- Radioactive Material -- Surfaces and Items in This Area May Be Contaminated"

This sign shall be used to post work areas where radioactive contamination may be present, e.g., hoods, benchtops, and sinks, etc.

3. "Caution -- Radioactive Materials"

This label is required on any container in which radioactive materials (including waste) are transported or stored or, in some cases, used. The label must specify radioisotope, activity level, and dates measured. It must be posted where radioactive material is present and on the outside door of the laboratory using or storing radioactive material.

4. Other posting requirements

1. **Radioactive Liquids and Radiochemicals in Storage.** Vials or containers must bear a durable label stating radionuclide, original amount and assay date.

2. **Experimental Apparatus and Glassware.** Any apparatus that will contain significant radioactivity overnight either due to prolonged experimentation or contamination must be individually labeled with an estimate of the quantity of radioactivity present. Where containers are used transiently in laboratory procedures in the presence of the user, no individual labels are required, but a "Caution – Radioactive Material" sign should be placed so that it clearly indicates the presence of radioactivity. Radioactive materials must be contained in areas with proper signage.

3. **Radioactive Waste.** All radioactive waste containers shall bear appropriate signs or labels. Logs shall be completed showing an estimate of the radioactivity in the waste containers.

4. **Notice to Employees.** Conspicuously post a current copy of RC Form 203-1 ("Notice to Employees") in a sufficient number of places to permit individuals working in or frequenting any portion of a controlled area to observe a copy on the way to or from such an area (such as the laboratory bulletin board).

RC FORM 203-1
(October 2011)

Department of State Health Services
P.O. Box 149347
Austin, Texas 78714-9347

NOTICE TO EMPLOYEES

TEXAS REGULATIONS FOR CONTROL OF RADIATION

The Department of State Health Services has established standards for your protection against radiation hazards, in accordance with the Texas Radiation Control Act, Health and Safety Code, Chapter 401.

YOUR EMPLOYER'S RESPONSIBILITY

Your employer is required to-

1. Apply these rules to work involving sources of radiation.
2. Post or otherwise make available to you a copy of the Department of State Health Services rules, licenses, certificates of registration, notices of violations, and operating procedures that apply to your work, and explain their provisions to you.

YOUR RESPONSIBILITY AS A WORKER

You should familiarize yourself with those provisions of the rules and the operating procedures that apply to your work. You should observe the rules for your own protection and protection of your co-workers.

WHAT IS COVERED BY THESE RULES

1. Limits on exposure to sources of radiation in restricted and unrestricted areas;
2. Measures to be taken after accidental exposure;
3. Individual monitoring devices, surveys and equipment;
4. Caution signs, labels, and safety interlock equipment;
5. Exposure records and reports;
6. Options for workers regarding agency inspections; and
7. Related matters.

REPORTS ON YOUR RADIATION EXPOSURE HISTORY

1. The rules require that your employer give you a written report if you receive an exposure in excess of any applicable limit as stated in the rules, license, or certificate of registration. The basic limits for exposure to employees are stated in 25 Texas Administrative Code (TAC) §289.202(f), (k), (l), and (m) (relating to Standards for Protection Against Radiation from Radioactive Materials) and 25 TAC §289.231(m) (relating to General Provisions and Standards for Protection Against Machine-Produced Radiation). These subsections specify limits on exposure to radiation and exposure to concentrations of radioactive material in air and water.

2. If you work where individual monitoring devices are provided in accordance with 25 TAC §289.202 or §289.231:

(a) your employer must furnish to you an annual written report of your exposure to radiation if:

(1) the individual's occupational dose exceeds 100 mrem (1 mSv) total effective dose equivalent or 100 mrem (1 mSv) to any individual organ or tissue; or

(2) the individual requests his or her annual dose report in writing.

(b) your employer must give you a written report, upon termination of your employment, of your radiation exposures if you request the information on your radiation exposure in writing.

INSPECTIONS

All licensed or registered activities are subject to inspection by representatives of the Department of State Health Services. In addition, any worker or representative of the workers who believe that there is a violation of the Texas Radiation Control Act, the rules issues thereunder, or the terms of the employer's license or registration with regard to radiological working conditions in which the worker is engaged, may request an inspection by sending a notice of the alleged violation to the Department of State Health Services. The request must state the specific grounds for the notice, and must be signed by the worker or the representative of the workers. During inspections, agency inspectors may confer privately with workers, and any worker may bring to the attention of the inspectors any past or present condition that the individual believes contributed to or caused any violation as described above.

POSTING REQUIREMENT

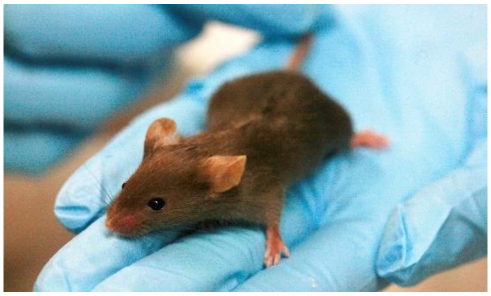
Copies of this notice shall be posted in a sufficient number of places in every establishment where employees are employed in activities licensed or registered, in accordance with 25 TAC §289.252 (relating to Licensing of Radioactive Material) and 25 TAC §289.226 (relating to Registration of Radiation Machine Use and Services), to permit employees to observe a copy on the way to or from their place of employment.

Applicable sections of 25 TAC Chapter 289 may be reviewed online, at www.dshs.state.tx.us/radiation/rules.shtm. Our license and/or certificate of registration and any associated documents, our operating procedures, and any "Notice of Violation" or order issued by the agency may be reviewed at the following location:

____

Figure 7. RC Form 203-1. Download here

RADIATION WORK IN ANIMALS



Any work with radiation in laboratory animals must be reviewed and approved by the Institutional Animal Care and Use Committee (IACUC).

Animals increase the potential for exposure to radioactive materials via aerosol generation, bites and scratches, shedding of infectious agents, and accidental releases.

The RSO and UV will take into consideration the security of animals housed at UTSA facilities. Measures are in place to ensure that radioactive contamination is not only minimized between animals and humans but also between animals within the facilities. These measures include work practices, PPE, risk assessments, SOPs, IACUC policies, housing requirements and vaccination.

1. All work shall be performed in rooms approved by the R&LSC and Institutional Animal Care and Use Committee (IACUC) and included on UTSA's Radiation License. These rooms must be marked by a warning tape bearing the radioactive symbol.

2. After a radioactive material has been introduced into an animal, its cage and equipment shall be marked by warning tape bearing the radioactive symbol. The name of the investigator, the radioisotope used, the quantity of radioactive material introduced into the animal (in microcuries), the date of exposure, and the route of exposure shall also be noted on the cage. The IACUC in conjunction with the R&LSC will review the procedures involving the use of radioactive materials in animals.

3. After radioactive materials have been introduced into experimental animals, each animal shall be identified. The cage, bedding, wastes, and in some cases the rack and the room must be recorded and treated as radioactive. This requires considerable care in the handling and disposal of equipment, waste, and animals.

4. It is the licensed PI's responsibility to have all radioactive waste (bedding, excreta, etc.) collected in approved plastic containers and surveyed for contamination. If contaminated, the waste is reported to RSP for disposal. All radioactive animal cadavers are to be tightly wrapped and placed in a freezer designated by RSP. Do not place animal cadavers directly into biological waste containers.

5. The PI is responsible for:

    a. Conforming to all regulations established by the IACUC.

    b. Notifying Laboratory Animal Research Center (LARC) personnel that animals containing radioisotopes will be housed in their facilities.

    c. Notifying RSP that animals containing radioisotopes will be housed in the Animal Care Facility and providing any additional information as requested.

    d. Ensure that cages are decontaminated before returning them to LARC for cleaning.

    e. Dispose of the carcass and bedding in accordance with the radioactive waste program.

INCIDENT RESPONSE AND EMERGENCIES

Work Hours (Monday-Friday 8am-5pm)

If an exposure, or injury, occurs during normal working hours contact Occupational Health/Student Health Services for medical attention.

Notify the Laboratory Safety Division.

In the event of a serious injury contact UTSA Police Department (x4911)

After work hours

After hours, and on weekends, if an exposure or injury occurs contact UTSA Police Department (x4911) for immediate assistance.

Below are guidelines for managing spills and emergencies where radiation is involved. At any point, no matter how small the spill, personnel can and should call the RSO for assistance in managing the situation. Emergency management is summarized in Appendix B of this plan.

MINOR SPILLS

Minor spills are defined as a spill of materials in microcurie amounts. Spills of this type are determined to be low hazard with no immediate risk to personnel or the environment.

1. Notify all persons in the room. Evacuate anyone not involved in spill clean-up to minimize the risk of cross contamination.

2. Confine the spill immediately, cover the spill with an appropriate absorbent material and decontaminate with an appropriate solution (see Decontamination for guidance on solutions for spill management).

3. Notify the RSO.

4. Place all contaminated items in a radiation waste container for pickup.

MAJOR SPILLS

Major spills are defined as spill of materials in millicurie amounts. Spills of this type may be a significant hazard to personnel and the environment.

1. Notify all personnel in the room and evacuate the area. Post a spill warning sign on the door.

2. Immediately contact the RSO and make no attempt to clean up the spill. Personnel must remain in the vicinity of the laboratory and be checked for contamination.

3. Decontamination of personnel and equipment, and spill management, will be carried out under the supervision of the RSO and San Antonio Fire Department HAZMAT if necessary.

4. No work should resume until the RSO notifies the PI that the area is safe.

ACCIDENTS INVOLVING AIRBORNE MATERIAL

Accidents involving radiation contaminated airborne particles include:

- Dust
- Mists
- Fumes
- Vapors
- Gases

The hazard level of these incidents is high due to the potential for ingestion or inhalation. The contamination can spread easily and large areas could become contaminated.

1. Notify all personnel in the room and evacuate the area. Post a warning sign on the door.
2. Make note of all personnel who may have been exposed.
3. Immediately contact the RSO and make no attempt to clean up the material.
4. Decontamination of personnel and equipment, and facilities, will be carried out under the supervision of the RSO and San Antonio Fire Department HAZMAT if necessary.
5. Do not re-enter the space, under any circumstance, until the area has been cleared by the emergency response team.

INJURIES AND EXPOSURES

Injuries resulting in the introduction of radioactive material into a wound must be treated immediately.

1. Wash the wound immediately with soap and warm water for at least 15 minutes. Encourage bleeding if the wound is already bleeding.
2. Contact the RSO immediately. The RSO will notify Occupational Health or Student Health Services.
3. Follow directions from the RSO to seek medical treatment, either on campus or at the nearest emergency facility.
4. If the wound is severe call UTSA Police Department for immediate medical assistance. Notify them that this a radiation exposure and provide the dispatcher with the radioisotope involved.

5. Notify your PI, manager, or supervisor to initiate an accident or exposure incident report. The report must be done at the earliest possible time, and within 24 hours of the incident. If the incident involved a contaminated sharp (including an animal bite) include this Form.

FIRES

Fires involving radioactive materials must be reported immediately to UTSA Police Department and the RSO. Do not attempt to manage a fire if you are not confident in the procedures. Always pull the fire alarm and request assistance from UTSA Police Department.

1. Notify all persons in the room. Evacuate anyone not needed in the immediate response.

2. Pull the fire alarm.

3. If the fire is small, and can be extinguished without spreading contamination (does not immediately involve radioactive materials) use an appropriate fire extinguisher. Otherwise evacuate the area immediately.

4. Call UTSA Police Department and request immediate fire response. Contact the RSO immediately.

NOTIFICATIONS

Always contact the RSO in the event of any incident or near miss. Outside of normal working hours contact UTSA Police Department, and the RSO, to summon immediate assistance, always notify the dispatcher if radiation is involved.

DECONTAMINATION

Removal of radioactive contaminants falls into two categories: 1) decontamination of personnel and, 2) decontamination of facilities. The degree of contamination must first be determined by conducting a Radiation Survey consisting of a radiation level survey and/or a contamination level survey. If a radiation level survey in a controlled radiation work area of a laboratory shows a continuous dose rate outside of shielding greater than 0.2 mrem/hr or removable contamination greater than 1000 dpm/100 cm^2 (beta-gamma) or 100 dpm/100 cm^2 (alpha), decontamination is required. For areas of a controlled laboratory, other than those designated radiation work areas radiation levels must not exceed 2 millirem in any one hour or 100 millirem per year and removable contamination must be less than 100 dpm/100 cm^2 as demonstrated by wipe survey.

PERSONNEL DECONTAMINATION

1. Prompt removal of surface contamination is necessary to prevent radioactivity from entering the body by ingestion, absorption, inhalation or through damaged skin and to prevent radiation overexposure of the skin. It is imperative that the methods used to carry out decontamination should not spread localized radioactive material or assist the contaminant in entering the body. Report personnel contamination to RSP immediately.

2. The following procedures have been used for removal of a wide variety of contaminants from personnel. (More drastic methods must be performed only under medical supervision.)

    a. Remove contaminated clothing and place it in a suitability labeled container.

    b. Monitor the person carefully to determine the level and location of contamination.

    c. Decontaminate in the following manner:

        i. Unless a large amount of radioactivity is involved (millicuries), carefully rinse the affected area with running water in a sink. Done quickly, rinsing can prevent possible absorption through the skin.

        ii. For solid contamination, use masking or adhesive tape to remove loosely attached contamination. This can prevent spreading the material or absorption into the skin, as can happen if solvents are used.

        iii. If there is a suitable solvent for the material which will not damage the skin utilize it to remove the material.

iv. If the above methods fail, cleanse the contaminated areas with mild detergent and water -- giving special attention to hair and fingernails.

v. If the contamination is localized, avoid spreading the contamination by general washing.

vi. If the procedures outlined above fail to remove the contaminants, soft brushes may be used for cleansing, but care must be taken to avoid the use of abrasive or strongly alkaline cleansers that may allow the contaminants to penetrate the skin.

vii. Another technique that can be used to remove radioactive contamination from the skin is using a potassium permanganate solution (or a mixture of saturated potassium permanganate and a 1 percent solution of sulfuric acid) poured over the contaminated area and rinsed thoroughly under running water. (Consult RSP before applying).

viii. If skin contamination cannot be easily removed after several attempts, notify RSP and seek medical attention.

ix. RSP will perform nasal wipes for later investigation if contamination is due to an airborne source.

If the contaminated individual also requires medical treatment, do not delay treatment. Provide information and assistance, if requested, to the medical caregivers to prevent the further spread of any contamination from the individual. Decontamination can proceed after the individual is treated or stabilized.

FACILITY DECONTAMINATION

1. Survey to determine the level and location of contamination.

2. Post appropriate signs to keep people out of area.

3. Mark off contaminated areas (masking tape is useful for this purpose).

4. Plan the specific decontamination procedure prior to taking action. Obtain an adequate supply of decontamination materials. Consult RSP as needed.

5. Cover clean areas with paper or plastic sheeting to prevent the spread of contaminants if the situation merits such action.

6. Wear personal protective equipment such as rubber gloves, shoe covers, and respirators as appropriate.

7. First, remove "hot" spots, then work from the perimeter toward the center. Do not use excessive water since this may cause the contamination to run off.

8. Use radiation wipes to help remove contamination.

9. Take care not to track contamination. Monitor all persons leaving the contaminated area -- particularly check soles of shoes and hands.

10. Isolate and retain mops, rags, brushes, and wash solutions until these can be surveyed for contamination.

TECHNIQUES

Techniques for removal of contamination from facilities are generally subject to consideration of the value of the contaminated items and the durability of the contaminated surfaces. A summary of techniques that have been successfully employed in decontamination of various materials follows.

A. Tools and Glassware

Decontamination methods fall into two broad classifications: corrosive and non-corrosive. It is always desirable to use a non-corrosive method, yet this is seldom practical since removal of the surface layers of material is more effective in putting ions back into solution than the very slow process of ion exchange or desorption by non-corrosive methods.

1. Non-corrosive

Clean with an aqueous solution of a mild dishwashing detergent. This should be tried before other methods. Since some elements, such as iodine, will become volatile when reacted with acids, only noncorrosive methods should be used when these elements are present.

2. Corrosive

A low hazard option would be to use decontamination wipes called RadiacWash https://www.nukepills.com/shop/radiacwash-radiation-decontamination-wipes/.

Wash with acid (chromic acid cleaning solution or dilute nitric acid) and rinse with water. The use of acid on metal tools may corrode them causing greater difficulty in future decontamination procedures. Metal objects may be decontaminated with dilute mineral acids (nitric), a 10 percent solution of sodium citrate or ammonium bifluoride.

When all other procedures fail for stainless steel, use hydrochloric acid. This is a good decontaminant, for the reason that it removes some of the surface; however, this procedure results in etching of the stainless steel, which makes it less desirable for future use.

Glass and porcelain articles may be cleaned with mineral acids, ammonium citrate, trisodium phosphate, cleaning solution (chromic acid) or ammonium bifluoride. When the glaze is broken on porcelain, or when active solutions are heated to extreme dryness in glass, decontamination is very difficult, and usually, it is more convenient to replace items. Plastics may be cleaned with ammonium citrate, dilute acids or organic solvents.

Over the counter decontamination solutions are advisable, such as No-count contamination spray.

Equipment - that is found to be contaminated after the initial treatment shall be stored in an isolated location, such as, in a properly labeled hood with adequate exhaust until more thorough decontamination procedures may be applied. If it is necessary to dismantle any equipment prior to decontamination procedures, careful surveys should be made during the operation. Contaminated equipment shall not be released from control of the laboratory for repair, or any other purpose until the level of activity has been reduced to a safe limit. Where the half-life of the contaminating element is short, it may be desirable to store tools and glassware for decay of activity rather than to attempt decontamination of them. In many cases, if the items are cheap or easily replaced, it may be simpler to dispose of such equipment in a recommended manner and replace with new equipment.

Equipment that is contaminated with long-lived isotopes and that cannot be satisfactorily decontaminated must be regarded as radioactive waste and disposed of in a proper manner.

Glassblowing, welding, brazing, soldering, etc., should never be permitted on equipment contaminated with radioactive materials unless it is done in special ventilated facilities, and special techniques are used to prevent the inhalation of radioactive dust and fumes.

It should be noted that the effectiveness of a decontaminating process is, for all practical purposes, complete at the end of the second repetition of the process. If necessary, other methods should then be considered for further decontamination.

Laboratory equipment should be surveyed for residual contamination following decontamination procedures. Decontamination seldom exceeds 99.9 percent efficiency and usually is considerably less efficient. If the residual contamination indicates that the level of activity is still greater than that specified as permissible then the equipment shall be regarded as radioactive waste.

B. Floors and Benches

Clean carefully as described below, using caution not to spread contamination. Use masking or adhesive tape to remove loose dry contaminants. For wet contaminants, use absorbent material such as paper towels, "Kimwipes", disposable diapers, or tissue. The following steps can then be used:

1. Use a mop with water or with water and detergent.

2. If mopping will not remove the contamination, proceed with a method suitable for the particular surface material. Consult RSP before employing any of the following methods. Linoleum may be decontaminated by carbon tetrachloride, kerosene, ammonium citrate solution or dilute mineral acids. Care should be taken not to dissolve sealing compounds at the edges and between cracks of the linoleum. Ceramic tile may be decontaminated by the use of mineral acids, ammonium citrate or trisodium phosphate solutions. Paint is sometimes successfully decontaminated by carbon tetrachloride or 10% hydrochloric acid; however, danger of dissolving the paint exists, and it is preferable to remove the paint and apply new coatings. With contaminated concrete, the surface can be removed using hydrochloric acid. Contaminated wood surfaces may need to be planed. For deeper contamination of surfaces consult RSP.

3. Detergents or wetting agents may be used for the decontamination of strippable plastics on polished stainless steel, glass or other smooth impervious laboratory surfaces.

4. Sinks, traps, and drains may be decontaminated by the following procedures:

a. Flush thoroughly with a large volume of water.

b. Scour with a rust remover and flush thoroughly.

c. Soak in a solution of citric acid prepared by adding 1 pound of acid to 1 gallon of water and flush thoroughly.

If contamination is not satisfactorily reduced after several attempts, it may be possible to cover a surface and/or add shielding to reduce high exposure levels until the radioisotope has decayed or a practical removal method devised. Such covered areas of contamination should be appropriately labeled and adequately documented in facility survey records.

APPENDIX A – GLOSSARY

The following is a list of some of the terms and units that are basic for understanding and applying principles of radiation protection.

Alpha particles are equivalent in mass to helium nuclei. They are emitted primarily during decay of heavy radionuclides including uranium, thorium, radium, and elements in the trans-uranium series. The energies for alpha particles emitted from typical radionuclides are in the 3-6 MeV range. Alpha particles, because of their large mass, have a relatively low velocity. This velocity and the double-positive charge mean that alpha particles interact strongly with matter, producing intense ionization as they dissipate their kinetic energy in very short distances. In general, alpha particles can travel only short distances (3 inches) in air and can be stopped by a thin sheet of paper or the dead layer of skin. When radionuclides that emit alpha particles become deposited within a person's body, those cells within a fraction of a millimeter of the site of deposition will receive very large doses of radiation.

Beta particles are emitted from the nucleus and are identical to orbital electrons in mass and charge. As a result of the emission of a beta particle (negative), a neutron is converted to a proton in the nucleus so that the atomic number is increased by one. The atomic mass number remains the same. Beta particles are more penetrating than alpha particles. Beta particles are emitted in a spectrum of energies; the average energy is 1/3 of the maximum.

Bremsstrahlung is electromagnetic radiation (like x-rays) produced when charged particles decelerate in matter. The production of bremsstrahlung depends directly upon the energy of the particle and the atomic number of the absorber.

Curie. The curie (abbreviated Ci) is the unit that describes the quantity of radioactivity, i.e., the number of nuclear transformations (or disintegrations) per unit time. One curie of activity equals 3.7 x 1010 nuclear transformations per second. The curie is a relatively large unit; most of the quantities of radioactivity used on campus are at the millicurie (mCi) or microcurie (µCi) level (i.e., 1/1,000th or 1/1,000,000th of a curie, respectively).

Electron volt is a small unit of energy used to describe radiation energies of individual particles or rays. One electron volt equals 1.6 x 10-19 Joule and is the kinetic energy an electron would have after being accelerated through a potential difference of 1 volt. The maximum beta energies of 3H, 14C, and 32P are respectively 18.6, 156, and 1700 keV (1 keV = 1 thousand electron volts).

Gamma rays and x-rays are part of the electromagnetic energy spectrum that also includes radio waves, visible light, and ultra-violet light. X-rays and gamma rays have very high energies, short wavelengths and readily penetrate matter. Gamma rays and x-rays differ only in their source. Gamma rays arise from the atomic nucleus while x-rays arise from orbital electron energy transitions. Both of these radiations interact with matter mainly by transferring energy to orbital electrons causing ionization. Dense materials with high atomic numbers, such as lead, make the best shields against these radiations.

Half-life. The half-life of a radionuclide is the period of time required for half of the atoms in a sample of that radionuclide to undergo nuclear transformation decreasing the activity by one-half.

Half-value layer. The thickness of a specific shielding material required to attenuate 50% of the radiation of a given x-ray or gamma-ray emitter. The half-value layer thickness depends on the density of the shielding and the energy of the emitter.

Ionization is the process by which a neutral atom or molecule acquires a positive or negative electrical charge.

Linear energy transfer is the linear density at which energy is deposited along the track of a particle or ray, usually expressed in keV per micron. Particles such as protons, neutrons, and alpha particles have much higher rates of linear energy transfer than gamma rays, x-rays, or electrons and consequently, do more biological damage and are assigned a higher quality factor for overall energy dose delivered to tissue.

Neutrons are electrically neutral particles. They may be produced from nuclear interaction when high-energy particles interact with nuclei or by fusion. Neutrons are the only particles able to render other materials radioactive.

Positrons are positively charged beta particles (equivalent in mass to electrons). They are emitted from the nucleus in the same manner as negatively charged electrons. The process results in a proton being transformed into a neutron. The resulting nucleus will have one less positive charge and the same mass number as the original nucleus. Positrons are emitted in a spectrum of energies. When the positron collides with a negative electron both particles are annihilated. The masses of the positron and electron are totally converted to energy in accordance with formula, E = mc2, two photons with energies of 0.511 MeV are produced. The annihilation radiations have the same characteristics as gamma rays.

Quality factor (QF) is a number by which absorbed doses are multiplied to obtain dose equivalent for radiation protection purposes. It is a quantity that expresses on a common scale the radiation harm incurred by exposed persons.

Rad is the unit of absorbed dose. One rad is the dose when any ionizing radiation deposits 100 ergs per gram in any material. Since one R of exposure in the energy range of 0.1 to 3 MeV dissipates 87 ergs per gram of air (or 96 ergs per gram in soft tissue), the units are said to be nominally equivalent.

Rem is the unit of dose equivalent that is used for radiation protection purposes. It is the product of the absorbed dose and a factor that relates it to the harmfulness to man. This latter factor is termed the Quality Factor.

Roentgen, R, the unit of exposure, is the amount of x-ray or gamma radiation that will produce 1 electrostatic unit (ESU) of charge per cubic centimeter of air at standard temperature and pressure.

X-rays (see gamma rays).

APPENDIX B – RADIATION EMERGENCY PROCEDURES

TYPE EMERGENCY	HAZARD	IMMEDIATE PRECAUTIONS/ACTIONS	FOLLOW-UP
Minor Spills (Microcurie amounts)	*Radiation:* No immediate radiation hazard to personnel. *Contamination: Low*	--Notify all persons in room. --Confine spill immediately. --Notify Radiation Safety Personnel (RSP). --Clean up spill.	Inform RSP prior to resuming work.
Major Spills (Millicurie amounts)	*Radiation:* May be great hazard to personnel. *Contamination:* Hazard to personnel & equipment.	--Notify all personnel to vacate room or area. --Make *no* attempt to clean up spill. --Vacate room or area. --Provide warning signs. --Notify RSO.	Decontamination of personnel and equipment (including spill) to be carried out under supervision of or by RSP.
Accidents involving: **—Dust** **—Mist** **—Fumes** **—Vapors** **—Gases**	*Radiation:* Internal hazard due to possible ingestion or inhalation. *Contamination:* Easily spread when airborne.	--Notify others to vacate laboratory or area. --Provide warning signs. --Notify RSP.	Do not re-enter laboratory until approved by RSP.
Injuries involving: **—Radiation hazard** **—Contamination**	*Contamination:* Wounds usually greatest hazard.	--Wash wound immediately in running water with soap. --Call physician of choice. --Notify RSP.	Permit no one involved in accident to return to work until approved by RSP and physician.
Fires involving: **—Radioactivity**	*Radiation:* Internal hazard from airborne activity. *Contamination:* May be spread by fire fighting techniques.	--Notify all persons in laboratory and pull fire alarm. --Attempt to extinguish fire if no radiation hazard & can safely be done. **--Call UTSA Police ASAP (x911) (210-458-4911, cell).** --Notify RSP.	Emergency activities will be governed by or in cooperation with RSP. UTSA Police will determine if local Fire Department is to be called.

APPENDIX C – GAMMA DOSE RATE CONSTANTS FOR SELECTED NUCLIDES

Nuclide	Γ	Nuclide	Γ	Nuclide	Γ
Antimony-124	9.8	Indium-111***	3.24	Rubidium-86	0.5
Barium-133	2.4	Indium-113m***	1.77	Scandium-47	0.56
Beryllium-7	0.3	Indium-114m	0.2	Selenium-75	2.0
Bromine-82	14.6	Iodine-123***	0.67	Silver-110m	14.3
Carbon-11**	5.9	Iodine-125***	1.5	Sodium-22	12.0
Cesium-137	3.3	Iodine-131	2.2	Sodium-24	18.4
Chromium-51	0.16	Iridium-192	4.8	Strontium-85	3.0
Cobalt-57	0.9	Iron-59	6.4	Tantalum-182	6.8
Cobalt-60	13.2	Manganese-54	4.7	Technetium-99m	0.7
Copper-64	1.2	Mercury-203	1.3	Thallium-170	0.025
Gallium-67	1.1	Molybdenum-99	1.8	Tin-113	1.7
Gallium-72	11.6	Potassium-42	1.4	Xenon-133	0.14
Gold-198	2.3	Potassium-43	5.6	Zinc-65	2.7
Radium-226	8.25				

Table 3. Gamma dose rate constant (Γ) for selected nuclides.

References

*Jaeger, R.C., et al., Engineering Compendium on Radiation Shielding, Vol. 1, (New York: Springer-Verlag, 1968), pp 21-30.

Γ is given in R-cm2/hr-mCi = 10× Γ in units of R-m2/hr-Ci (see below)

**A Manual of Radioactivity Procedures (National Bureau of Standards Handbook No. 80 (Washington, D.C.: Supt. of Docs., U.S. Government Printing Office, Nov. 1961), Appendix A, pp. 137-140.

***Stanford University, Health Physics

In order to derive the exposure rate in terms of R per hour per curie at one meter, the above Γ values in the table should be divided by 10.

APPENDIX D – PREGNANCY DECLARATION FORM

UTSA
Laboratory Safety

DECLARATION OF PREGNANCY FORM

SECTION I – VOLUNTARY DECLARATION OF PREGNANCY

In accordance with the Texas regulations for Radiation Control in 25 TAC§289.202(m)[1] *"Dose equivalent to an embryo/fetus"* I voluntarily declare that I am pregnant. My estimated date of conception is as regulation requires.

I understand that the dose equivalent to my embryo/fetus during my entire pregnancy will not be allowed to exceed 0.5rem (5mSv) *unless this limit has already been exceeded between the time of conception and the date of declaration as stated*. By certifying this document, I understand that I have met the definition of a declared pregnant person.

______________________________ ________________________

Signature and Date abc123

SECTION II – RESCINDING DECLARATION OF PREGNANCY

The pregnant worker may undeclare the above declaration in writing at any time without explanation and the dose monitoring will be discontinued and the applicable radiation worker occupational dose limits will apply.

I, __________________________________declare that I no longer wish to be considered a declared pregnant person.

______________________________ ________________________

Signature and Date abc123

[1] 25TAC§289.202 © (7) Declared pregnant woman--A woman who has voluntarily informed the licensee, in writing, of her pregnancy and the estimated date of conception. The declaration remains in effect until the declared pregnant woman voluntarily withdraws the declaration in writing or is no longer pregnant.