THE UNIVERSITY *of* NORTH TEXAS
HEALTH SCIENCE CENTER *at* FORT WORTH

Radiation Safety Manual

SECTION I

1. Record of Changes

OWNER:	**Environmental Health & Safety**		Date
PREPARED BY:	George K. Osei, Ph.D. RSO		12/06/2023
APPROVED:	**HSC Radiation Safety Committee**		04/11/2024
IMPLEMENTED:			
RETIRED:			
Revision No.	**Date**	**Review/Changes**	**Reviewer**

2. Applicability

This institutional radiation safety manual must be adopted as a policy and utilized in conjunction with all Hazard Registrations. These documents must be readily accessible to all laboratory personnel.

3. Approval and Implementation

This Radiation Safety Manual is hereby approved for the University of North Texas Health Science Center. This plan shall apply to all HSC personnel participating in all scientific and medical research activities at HSC facilities or sanctioned activities. The details of this plan are the institutional policies directing the safe use of radioactive material and radiation-producing devices in research. This plan is effective immediately and supersedes all previous editions.

Approved: DocuSigned by: 6517D995B7564CE... Date: 4/29/2024

Seth Willmoth
Associate Vice President of Facilities Management and Services
Interim Director of Environmental Health and Safety
UNT Health Science Center
Fort Worth, Texas

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4. Contact Information

4.1 EH&S Radiation Safety Program

Subject	Name	Title	Telephone	Email
Radiation Safety Program	George K. Osei, Ph.D. Maya Nair, Ph.D. Alan Corbitt	Radiation Safety Officer Assistant Radiation Safety Officers	817-735-2243 817-735-5431 817-735-2697	George.Osei@unthsc.edu Maya.Nair@unthsc.edu Alan.Corbitt@unthsc.edu
Environmental Health & Safety	Seth Willmoth	Interim EH&S Director	817-735-5181	Seth.Willmoth@unthsc.edu
Occupational Health	Occupational Health		817-735-2273	

4.2 Emergency Phone Numbers

Police/Fire Emergency	Police Dispatch	In-house phone: Ext 2600 or 911 Cell phone: 817-735-2600
Emergency Power Outage	Facilities	Ext: 2181 / 817-735-2181
Hazardous Material Release/Spill	Police Dispatch	In-house phone: 2600 Cell phone: 817-735-2600
Hazardous Material Exposure: Skin, Eyes, Ingested, Inhaled, Injected	Occupational Health	Ext. 2273 / 817-735-2273

4.3 Other Important Institutional Phone Numbers

Hazardous material/ Waste	Ext: 2697 / 817-735-2697
Facilities Non-Emergency	Ext: 2181 / 817-735-2181
Environmental Health and Safety	Ext: 2245 / 817-735-2245
Radiation Safety	Ext: 2243 / 817-735-2243
Campus Police/Security Non-Emergency	Ext: 2210 / 817-735-2210

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4.4 HSC Relevant Website links

Report an Ethics Complaint	https://secure.ethicspoint.com/domain/media/en/gui/56566/index.html
First Report of Injury	https://www.unthsc.edu/administrative/wp-content/uploads/sites/23/WC_Employee_Forms.pdf
Student Complaints	https://unthsc.qualtrics.com/jfe/form/SV_1Mn0IlToxxTH3QF?Q_JFE=qdg
Radioactive Waste Pickup Requests	https://www.unthsc.edu/safety/radioactive-waste-removal-request-form/
UNTHSC IACUC	https://www.unthsc.edu/research/animal-research/iacuc/
UNTHSC Radiation Safety	https://www.unthsc.edu/safety/radiological-and-biosafety/radiation-safety-manual/
UNTHSC IRSC	https://www.unthsc.edu/safety/radiological-and-biosafety/radiation-safety-manual/

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SECTION II

1. INTRODUCTION

1.1 Scope

The Radiation Safety Office at the University of North Texas Health Science Center (UNTHSC) protects radiation users, coworkers, and the general public from high levels of radiation and radioactive materials. This manual is intended to serve as the minimum defined radiation safety criteria for radiation materials use, storage, and disposal. This may be used by UNTHSC laboratories dealing with radiological hazards to develop a laboratory-specific standard operating procedure (SOP) for dealing with radiological hazards. However, all alterations must assure radiation safety at or above the level stated in this document's best practices. The containment, safety equipment, personal protective equipment (PPE), and rules and procedures in this manual as a policy of UNTHSC, ensure that investigators can properly manage radioactive materials in accordance with those of the Texas Department of State Health Services (DSHS), the United States Nuclear Regulatory Commission (NRC), and the Occupational Safety and Health Administration (OSHA), which are intended to protect everyone while interfering with their daily activities with radiation as little as possible.

1.2 Federal, State, and Institutional Regulations and Policies

Federal, State, and Institutional Regulations and Policies for ionizing and Non-ionizing Radiation are as follows, but not limited to:
Federal Regulations

- Title 10: Energy Chapter 1Nuclear Regulatory Commission (NRC) Part 20 {10 CFR 20}"Standards for Protection Against Radiation"
- Title 10: Energy Chapter 1: Nuclear Regulatory Commission (NRC) Part 19 {10 CFR 19} "Notices, Instructions and Reports to Workers: Inspection and Investigation"
- Title 10: Energy Chapter 1: Nuclear Regulatory Commission (NRC) Part 21 {10 CFR 21}"Reporting of Defects and Noncompliance"
- Title 29: Labor CFR 1910 "Occupational Safety and Health Standards – Subpart Z Toxic and Hazardous Substances; 1910. 1096 Ionizing Radiation"
- US NRC Regulatory Guide 8.29 "Instructions Concerning Risks from Occupational Radiation Exposure"

State of Texas Department of Health

- Texas Department of State Health Services (DSHS), Radiation Control Program
- Title 25 of the Texas Administrative Code (TAC), §289
- HSC Institutional Policies

These regulations set the minimum acceptable standards and include notices and instructions for workers. A summary of Title 10 CFR 19 and the Texas DSHS "Notice to Employees" can be found in Appendix I.

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The determination of the containment level, equipment, and personal protective equipment (PPE) needed will be defined by the UNTHSC Radiation Safety Committee (RSC), and The Office of Environmental Health and Safety (EH&S). For questions regarding this document, please contact UNTHSC EH&S at (817) 735-2243.

The Texas Department of State Health Services (DSHS) became involved in radiological health-related activities in 1947. By utilizing efficient licensing, registration, inspection, enforcement, and emergency response procedures, DSHS worked to protect the public from unnecessary radiation exposure. The Atomic Energy Act of 1954 established the U.S. Nuclear Regulatory Commission (NRC) to regulate radioactive fuel sources for nuclear reactors and byproduct materials resulting from nuclear fission. States that have achieved Agreement State status have the authority to control byproduct material.

States become Agreement States by establishing programs to assume NRC regulatory authority under the Atomic Energy Act of 1954, as amended. Section 274 of the Act provides a legal foundation for the NRC to delegate portions of its regulatory authority over byproduct materials (radioisotopes), source materials (uranium and thorium), and certain quantities of special nuclear materials to the states. The mechanism for transferring NRC authority to a State, according to Section 274b of the Act, is an agreement signed by the Governor of the State and the Chairman of the Commission. Agreement States must maintain program compatibility and are routinely reviewed for adequacy and compatibility by the NRC's Management Review Board every four years.

Since signing the Agreement in 1963, Texas has regulated radioactive materials. As previously stated, Texas had previously regulated Naturally Occurring Radioactive Materials, over which the NRC had no authority. Furthermore, Texas regulates radiation sources such as lasers and x-ray machines, including mammography, which are not regulated by the NRC. The Texas Radiation Control Program issues approximately 25% of radioactive materials permits and 75% of X-ray, Mammography, and Laser permits in total.

1.3 Background Radiation

Every day, we are exposed to radiation from both natural and man-made sources, such as minerals in the ground and medical X-rays. We are surrounded by background radiation from nature. Depending on the quantity of naturally occurring radioactive elements in soil, water, and air, background radiation varies from location to location and over time. The annual background radiation dose you and your family receive depends on several factors. The percentage of annual background radiation dose derived from various natural sources is depicted in the following chart (Figure 1.1). The average annual radiation dose per person in the United States is 620 millirem (6.2 millisieverts), according to the National Council on Radiation Protection and Measurements (NCRP). The sources of this average dose are depicted in the pie chart in Figure 1.2.

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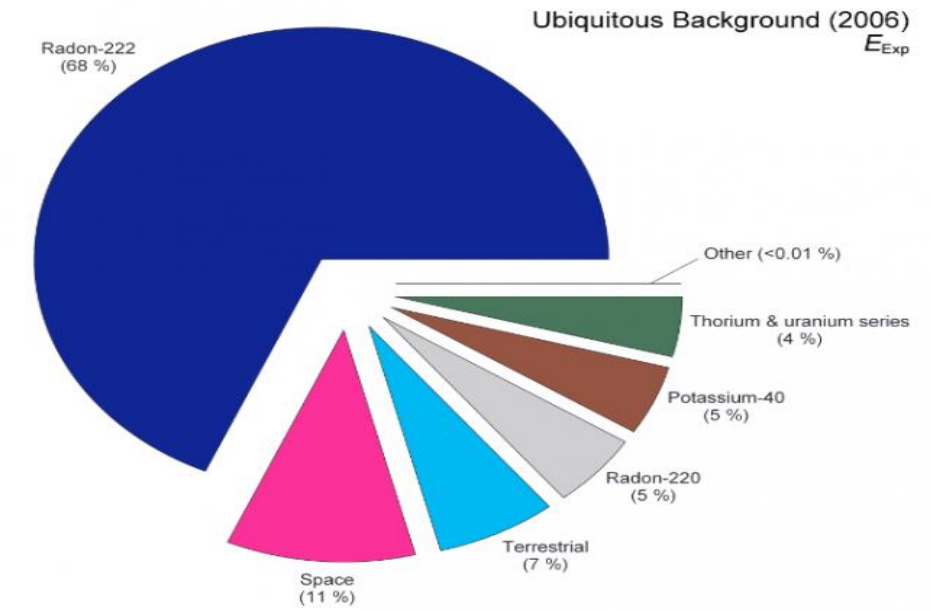
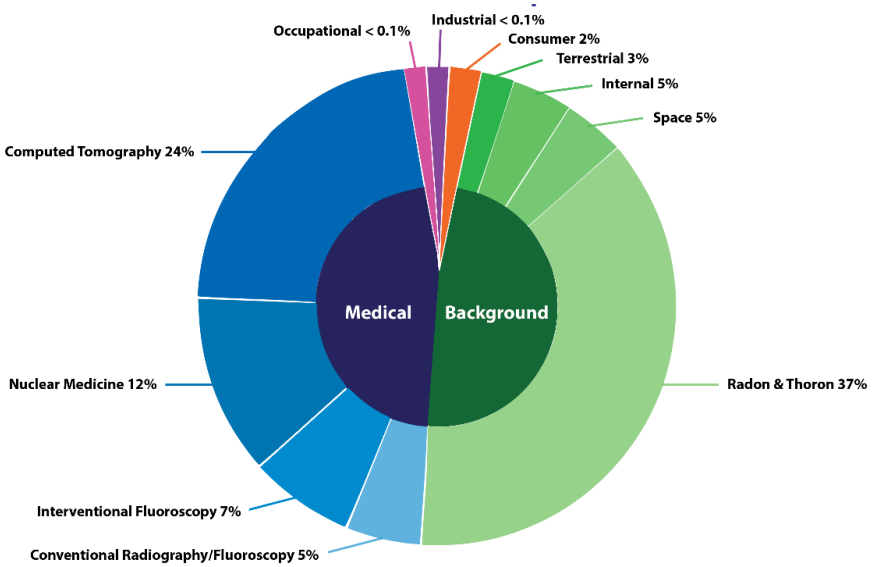


Figure 1.1: Ubiquitous background radiation. Source: NCRP Report 160



Average Annual Radiation Dose

Sources	Radon & Thoron	Computed Tomography	Nuclear Medicine	Interventional Fluoroscopy	Space	Conventional Radiography/ Fluoroscopy	Internal	Terrestrial	Consumer	Occupational	Industrial
Units											
mrem (United States)	228 mrem	147 mrem	77 mrem	43 mrem	33 mrem	33 mrem	29 mrem	21 mrem	13 mrem	0.5 mrem	0.3 mrem
mSv (International)	2.28 mSv	1.47 mSv	0.77 mSv	0.43 mSv	0.33 mSv	0.33mSv	0.29 mSv	0.21 mSv	0.13 mSv	0.005 mSv	0.003 mSv

Figure 1. 2: Sources of radiation exposure. Source: NCRP Report 160

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1.4 Objective

The main goals for radiation protection can broadly be categorized as (a) those aimed at shielding personnel from immediately detectable negative effects following exposure, and (b) those aimed at preventing latent injuries or conditions that could arise from much lower levels or repeated exposures.

Radiation is energy that takes the form of fast-moving particles and electromagnetic waves. The two major types of radiation are ionizing and non-ionizing. Ionizing radiation has the ability to ionize atoms with sufficient energy to cause tissue damage by destabilizing molecules within cells. Although non-ionizing radiation is required for survival, excessive exposure can result in tissue damage.

1.4.1 Ionizing Radiation

Ionizing radiation comes in two different forms: electromagnetic (x-rays, gamma rays) and particulate (alpha, beta, and neutrons). The ionizing radiation symbol is represented in Figure 1.3a.

Figure 1.3a: Ionizing radiation symbol

The National Council on Radiation Protection and Measurements, Report No. 116, Limitation of Exposure to Ionizing Radiation, aptly states the protection objectives related to this type of hazard. According to the report, "The specific goals of radiation protection are:

1. In order to avoid clinically significant radiation-induced deterministic (non-stochastic) effects, it is important to adhere to dose limits that are below the threshold levels that appear to be safe.
2. To keep the risk of cancer and genetic effects, as well as stochastic (probabilistic) effects, within a reasonable range while taking societal needs, values, and economic considerations into account.

Alpha particles are massive charged particles that are emitted from the nucleus with distinct energies and are identical in mass and charge to ^{4}He nuclei (for instance, ^{238}U emits alpha particles).

With the same mass as an electron, beta particles are light-charged particles that can be either positive (positron) or negative (negatron). They are emitted from the nucleus at a continuous range of energies up to maximum energy; for instance, ^{22}Na emits positrons while ^{32}P, ^{3}H, ^{14}C, ^{35}S, and ^{131}I all emit negatrons.

Gamma rays are distinct electromagnetic radiation waves with high energies that come from the nucleus. (for example, ^{131}I, ^{125}I, ^{57}Co, ^{51}Cr, ^{137}Cs).

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Table 1.1:Some properties of ionizing radiation

Type	Energy range (MeV)	Penetration distance in water*	Penetration distance in air*
α	3-9	<0.05 mm	<10cm
B	≤ 3	<4mm	1 m
x-ray	$< 10^{-2}$	< 1 cm	< 3 m
Γ ray	10-2 - 10^{1}	< 20 cm	>3m

*Distance at which half of the radiation has been absorbed

1.4.2 Non-Ionizing Radiation

Non-ionizing radiation is made up of electromagnetic radiation with frequencies ranging from ultra-low frequency (ELF) to ultraviolet (UV). Figure 1.3b illustrates symbol usual use for non-ionizing radiation.

Figure 1.3b: Non-ionizing radiation symbol

Laser Radiation

Preventing thermal injury to personnel's eyes or skin from direct or scattered laser beams is the main goal. Due to the use of laser devices, protection from associated non-beam hazards like fire, electrical, compressed gas, and generated aerosols must also be considered. If the eyes of those who have been exposed to certain wavelengths of laser beams are not sufficiently shielded, potential long-term effects could happen.

UV Radiation

UV-A, UV-B, and UV-C radiation exposure are typically limited to prevent thermal burns to the skin and eyes. Engineering controls or the use of personal protective equipment can also be used to prevent potential long-term harm that could result in cancer or cataracts.

Magnetic Field, Microwave, and other Electromagnetic Radiations

It is believed that the only harm that could result from these risks would be any acute heat buildup inside a person's body. The sole goal of current regulations and standards is to prevent harm from transient exposures to these risks. Research on the long-term effects of these exposures is still ambiguous.

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1.5 Electromagnetic Spectrum

The radiation variation illustration shown in Figure 1.4 indicates that as the frequency increases, the energy of the radiation shown on the spectrum increases from left to right.

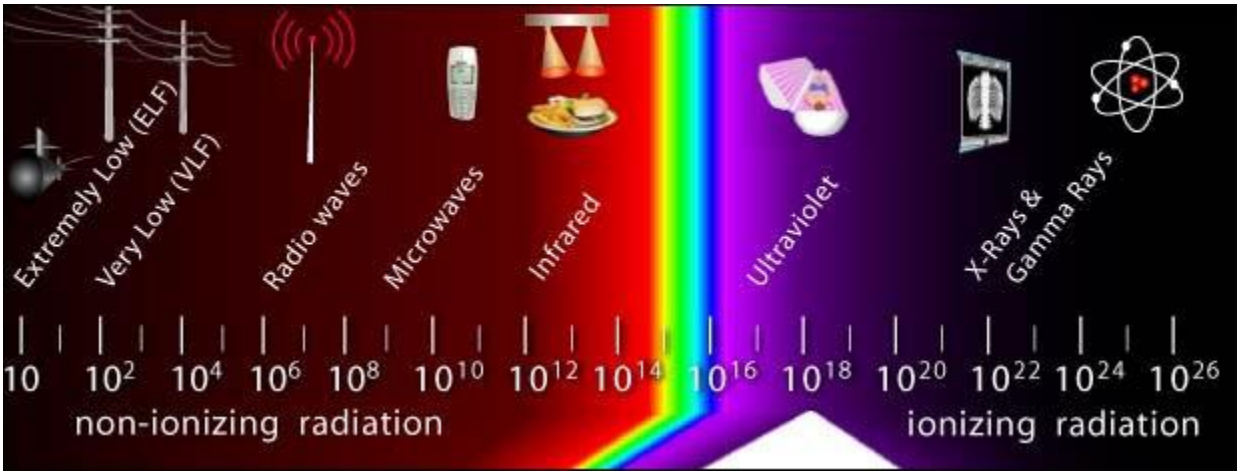

Figure 1.4: Radiation variation illustration. Source: OSHA

The International Organization for Standardization (ISO) and the International Atomic Energy Agency (IAEA) jointly announced the adoption of a new ionizing radiation warning symbol (ISO 21482) on February 15, 2007, to replace the existing trefoil symbol. This symbol (Figure 1.5) shows a black trefoil with radiation waves streaming from it, a black skull and crossbones, a running figure, and an arrow pointing away from the scene on a red background.

Figure 1,5: High-level sealed-source ionizing radiation symbol. Source: ISO 21482

The symbol is meant to be used with IAEA Category 1, Category 2, and Category 3 sources, which are dangerous sources that can cause death or serious injury. Examples of these sources include food irradiators, cancer teletherapy machines, and industrial radiography equipment. The symbol should be attached to the source-containing device as a warning not to disassemble it or approach it any closer. It will only be noticeable if someone attempts to disassemble the device; it won't be noticeable during normal use. No access doors to buildings, packages being transported, or containers will bear the symbol.

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2. BIOLOGICAL EFFECTS OF IONIZING RADIATION

2.1 Radiation Biological Effects

Not all of the energy in a radiation field is deposited in the living tissues of the person who is in it. As a result, a distinction must be made between the amount of ionizing radiation to which an individual is exposed and the amount of energy deposited in the body. **Exposure** is frequently expressed in **roentgens,** which is a measure of the amount of ionization that radiation (x- or gamma rays) can produce in air. The amount of radiation energy absorbed by the body is referred to as the "**dose,**" and it is commonly measured in **rads** or **grays**.

Different types of radiation do not always produce additive doses. This is primarily due to the fact that they deposit energy in different ways as they pass through living tissue. A radiation with short energy deposit, such as alpha, has the potential to cause more biological damage than a radiation with a longer energy deposit, such as X-ray. A factor is used to adjust for the quality of different radiations so that doses can be added for radiation protection. This quality factor is multiplied by the absorbed dose in rads to produce dose equivalent units in **rems** or **sieverts**. Rems can be used to ensure that a person has not received a dose that exceeds the maximum allowable limits.

The biological effects of ionizing radiation can be divided into two categories: acute and delayed effects.

Acute effects are caused by high doses of radiation administered in a short period of time. These effects are determined by how much and what part of the body is exposed and for how long.

Classification of acute radiation syndrome to the skin at different exposure levels and the whole body are indicated in Tables 2.1 and 2.2, respectively.

Table 2.1: Acute radiation syndrome to the skin

Dose in rads (Gy)	**Effect**
200-300 (2-3)	Epilation
>300 (>3)	Radiation dermatitis and erythema
1000-2000 (10-20)	Transepidermal injury
>2000 (>20) (single exposure)	Radionecrosis
>5000 (>50) (over extended period)	Chronic dermatitis

The delayed effects of radiation are those that appear years after the initial exposure. Delayed radiation effects can occur as a result of previous acute, high-dose exposure or chronic low-level exposure over time. It should be noted that there is no single disease associated with the long-term effects of radiation; these effects manifest in humans simply as a statistical increase in the incidence of pre-existing conditions or diseases.

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Table 2.2: Effects of short-term whole-body radiation exposure on human

Dose in rads (Gy)	Effects on humans
0 - 25 (0 - 0.25)	No detectable clinical effects. Possible delayed effects.
25 - 100 (0.25 - 1)	Transient decreases in lymphocytes and neutrophils. Disabling illness is uncommon; exposed individuals should be able to continue with their normal activities. Delayed effects are possible, but serious effects on the average person are extremely unlikely.
100 - 200 (1 - 2)	Around 20-25% of people experience nausea and fatigue, with possible vomiting above 125 rads (1.25 gy). Reduced lymphocytes and neutrophils, resulting in a delayed recovery. Delayed effects may result in a 1% reduction in life expectancy.
200 -300 (2 - 3)	Nausea and vomiting on day 1. Latent period of up to 2 weeks, possibly longer. Symptoms appear after the latent period but are not severe: loss of appetite, general malaise, sore throat, pallor, petechia, diarrhea, moderate emaciation. Unless complicated by poor health or a superimposed injury or infection, recovery should take about 3 months.
300 - 600 (3 - 6)	One may experience nausea, vomiting, and diarrhea in the first few hours. A latent period with no definite symptoms could last up to a week. Epilation, loss of appetite, general malaise, and fever in the second week, followed by hemorrhage, purpura, petechia, mouth and throat inflammation, diarrhea, and emaciation in the third week. Some deaths occur within 2-6 weeks; 50% of those exposed at approximately 450 rads (4.5 gy) may die; others may recover within 6 months.
>600 (>6)	One may experience nausea, vomiting, and diarrhea in the first few hours. In some cases, there is a short latent period with no definite symptoms during the first week. Diarrhea, hemorrhage, purpura, mouth and throat inflammation, and fever toward the end of the first week. Rapid emaciation and death as early as the second week, with up to 100% of those exposed eventually dying.

2.2 Radiation Protection Standards

According to current scientific evidence, there may not be a risk-free level of radiation exposure. In other words, even the smallest exposure has a chance of resulting in a stochastic/late effect like cancer or genetic damage. The NRC and DSHS have established annual radiation exposure limits based on the conservative assumption that there is no safe level (Table 2.3). This assumption has led to the general philosophy of keeping all exposures "**As Low As Reasonably Achievable" (ALARA)**, rather than just below recommended levels or regulatory limits.

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ALARA limits are the fundamental requirements for current radiation safety practices, which means that every effort must be made to keep employee and public doses below the required limits. The regulatory guideline requires radiation use facilities to achieve less than or equal to 10% of applicable legal limits, such as air and water release limits, exposure limits, or contamination limits. All experimental procedures should be scrutinized in order to reduce unnecessary exposures.

Table 2.3: Annual radiation dose limits

Body Part	**Annual Limit (rem)**
Whole body	5 (0.05 Sv)
Skin or Extremity	50 (0.5 Sv)
Lens of the eye	15 (0.15 Sv)
Embryo/Fetus	0.5/gestation period (0.005 Sv)
Members of the public	0.1
Minor	10% of Adult limit

The dose to an embryo or fetus from a declared pregnant woman's occupational exposure during the entire pregnancy shall not exceed 0.5 rem (500 mrem). It is recommended that the embryo or fetus receive no more than 0.05 rem in any given month.

The NRC and DSHS both require occupational workers to be instructed on the hazards associated with radioactive material and radiation, as well as the precautions and safety measures to be taken to minimize exposure (10 CFR 19.12 and §289.203). Licensees are advised that such instructions must include special instructions to females of childbearing potential about the risks of prenatal radiation exposure to the unborn fetus.

HSC has established an ALARA action level of less than 10% of annual radiation exposure limits (125 mrem in every monitoring quarter) mandated by regulation agencies (25 TAC 289.202(q)). Each calendar quarter, annual cumulative radiation exposures are reviewed. If monitoring reveals that a worker has exceeded an action level of the applicable radiation exposure limits, an investigation will be conducted to determine the cause of the exposure and to develop methods to control future exposures. The supervisor will report on the cause of the exposure as well as any steps taken to reduce future exposures. Individual counseling will be provided to personnel who submit two consecutive monitoring badges that exceed the action limit. At the Radiation Safety Committee's next quarterly meeting, a summary of exposure for any individuals who exceed the action level will be presented.

2.3 External Radiation Protection Principles

Time, distance, and shielding are the three basic concepts that influence an employee's exposure to ionizing radiation. Radiation doses are proportional to the amount of time spent in the field.

2.3.1 Time

Time is a critical factor when calculating an employee's amount of exposure to radioactive material. Radiation doses are proportional to the amount of time spent in the field. The amount of external radiation exposure is determined by the amount of time an employee spends near the source of radiation. When working with gamma and x-ray materials, time should be kept to a minimum.

2.3.2 Distance

Radiation exposure decreases with distance from the source, and the required distance is determined by the energy of the radiation and the activity of the source. The radiation dose received from a source is inversely proportional to the square of the separation distance. Because gamma rays can travel long distances, they are the primary radioactive material of concern. Alpha and beta particles have lower energy and travel less distance. When working with radioactive materials, keep in mind that doubling your distance from the source reduces your exposure level by a factor of four. For example, if a person sits four feet away from the radiation source, the exposure level is one-quarter that of if the same person sat two feet away from the radiation source.

2.3.3 Shielding

Shielding is any substance used to attenuate radiation to acceptable levels between the employee and the radiation source; therefore, the larger the shield around a radiation source, the less exposure there will be. The amount of shielding required to protect employees is determined by the type of radiation and its energy level. Certain materials, on the other hand, are more effective at shielding specific types of radiation (Figure 2.1).

Alpha: Alpha particles do not penetrate deeply into objects and can be stopped by paper, clothing, or skin. However, there is no defense for the body tissues against alpha emitters when ingested or inhaled.

Beta: Use low atomic number materials like plastics, Lucite, Plexiglas, and glass for beta radiation shielding.

Gamma and x-ray radiation: The best absorbers or shields for X- and gamma rays are typically made of high-density and high atomic number materials, such as lead. The same level of protection can be achieved by using steel, concrete, brick, or other materials in appropriately greater thicknesses. Figure 2.2 illustrates the basic radiation protection concepts adhered to accomplish ALARA principle.

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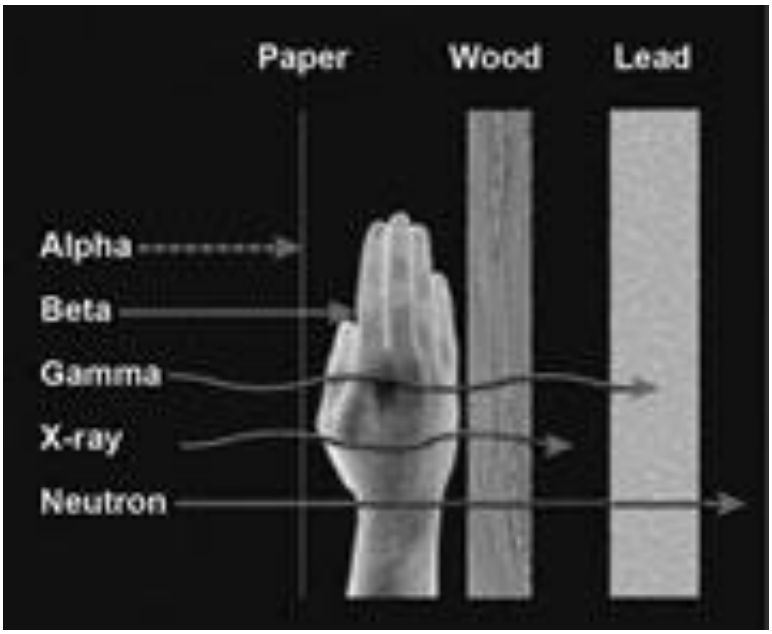

Figure 2.1: Effective shielding material for type of radiation

Figure 2.2: Illustration of basic radiation protection concepts

2.4 Internal Radiation Protection Principles

Internal exposure occurs as a result of radioactive material absorption, ingestion, or inhalation into the body. There are numerous ways (breathing radioactive gases, vapor or dust, consumption of filth from contaminated hands, food, drink or tobacco products, entering through wound, or absorption through the skin) that this substance can be incorporated into the body.

Radiation doses are difficult to calculate because of different factors, including the material's physical and chemical form, entry mode, and the metabolism of the individual. Because the tissue is continually exposed to radiation until the radioactive material has degraded or been eliminated, there is a greater risk when there is internal contamination. The biological half-life will determine how quickly the body will eliminate the radionuclide. The containment of the radioactive source is the primary method of defense against internal radiation.

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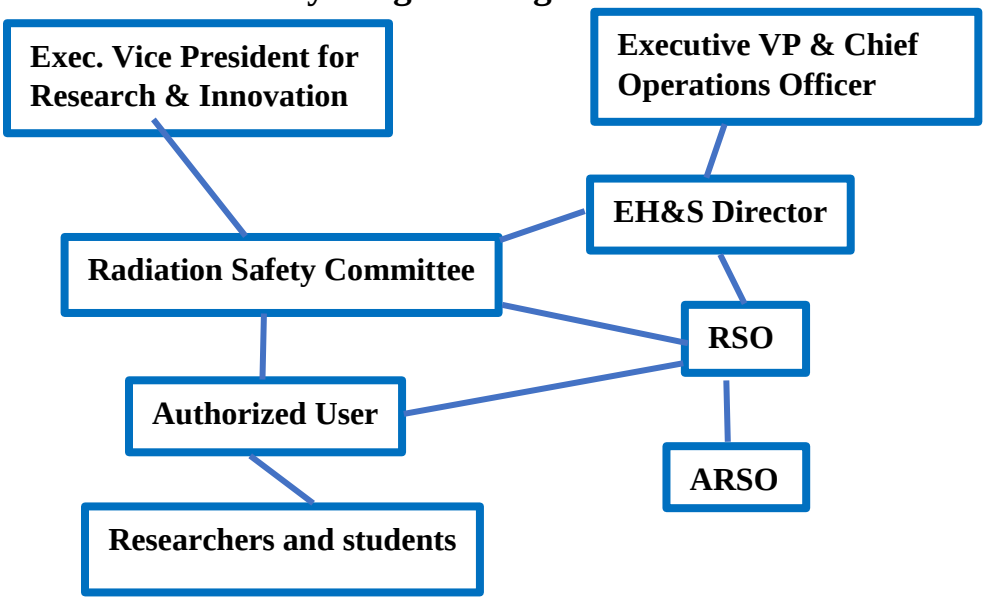
3. PROGRAM ADMINISTRATION AND RESPONSIBILITIES

3.1 Radiation Safety Program Organizational Chart



3.2 Executive Vice President of Research and Innovation

The Executive Vice President of Research (EVPR) is the main oversight official for all UNTHSC campus-related research activities. The EVPR has the authority and responsibility to perform the following actions relevant to the Radiation Program including but not limited to:

- Revoke, retract, and/or modify any research activity occurring on the UNTHSC campus.
- Monitor all human and non-human research activities occurring on the UNTHSC campus.
- Appoint RSC members, including the Chair, Vice-Chair, and *Ex Officio* members.
- Retract or modify RSC charters, policies, and procedures.
- Review documentation created, maintained, and/or authorized by the RSC.

3.3 Executive Vice President & Chief Operations Officer

The Executive Vice President and Chief Operations Officer (COO) is the primary oversight official for EH&S. The COO has the responsibility and authority to perform the following actions relevant to the Radiation Safety Program including but not limited to:

- Review the EH&S Program.

3.4 Radiation Safety Committee

The establishment of an administrative structure to oversee the ownership and use of radiation sources within the University is mandated by NRC and Bureau of Radiation Control regulations. The Radiation Safety Committee (RSC), a part of this structure that is separate from other administrative organizations, is in charge of ensuring that licensed material will be used safely and in accordance with relevant laws and licenses. The following are some of the responsibilities of the Committee:

a. To develop and publish university policies for purchasing, using, and disposing of radioactive materials and radiation-producing equipment.

b. To set up administrative controls to make sure that every user complies with University, State, and Federal laws.

c. To assess the use of radioactive material or radiation-producing devices within the institution from the perspective of radiation safety and either approve or disapprove it in advance.

d. Establish possession limits and restrictions as well as special conditions and requirements that may be required to ensure radiation safety.

e. Create and disseminate information on radiological safety for staff and student use.

f. Investigate radiation-related incidents to identify their causes and find ways to prevent them from happening again.

g. Maintain records of all transactions, communications, and reports related to the Committee's work, including those approving the use of radioactive materials and other sources of ionizing radiation.

h. Give the Committee's Radiation Safety Officer the power to represent the group in between meetings. At the appropriate intervals, the RSO will submit a report to the committee for review of all actions.

i. Examine all plans for new construction or structural alterations that involve the use of radioactive materials or radiation-producing equipment.

j. Make suggestions for and put disposal methods for radioactive waste into action.

The Radiation Safety Officer (RSO) will be one of the Committee's minimum of five members. The committee meets at least quarterly in a calendar year, or more frequently as needed. The Human Use of Radioisotopes and Radiation will be the subject of a formal ALARA audit of HSC's Radiation Safety Program at least once a year, which will also include a review of the safety procedures, previous operations, and the radiation safety perspective. The audit's objective is to assess the effectiveness of the ALARA program.

3.5 Radiation Safety Officer

The overall Radiation Safety Program is the responsibility of the Radiation Safety Officer (RSO). The RSO's duties and responsibilities include, but are not limited to, the following:

a. Serve as UNTHSC's licensing liaison officer in all licensing matters.

b. In charge of the operational aspects of radiation safety to ensure compliance with rules and regulations, as well as all license terms and conditions and any other applicable regulations.

c. Oversee the day-to-day radiation safety program.

d. Ensure that radioactive materials, both sealed and unsealed, are used only by or under the direct supervision of individuals authorized by the licenser and that all workers/students wear personnel monitoring equipment when required.

e. Provide licensed material users with guidance and direction on the safe operation and handling of radioactive materials, as well as the use of radiation survey instruments.

f. Instill in employees the ALARA philosophy, and guide, instruct, and train licensed users in the safe operation and handling of radioactive materials, as well as the use of radioactive survey instruments. Guidance on relevant changes to reduce exposures is also provided.

g. Examine the dosimetry reports for all monitored personnel to see if any unnecessary exposures are occurring. Will investigate the cause of any excessive dose within 30 days and, if necessary, take corrective action to prevent recurrence.

h. Compile and keep an inspection report for each investigation. All monitored personnel will receive an annual written notification of exposures.

i. Responsible for preparing and labeling radioactive waste for transportation, will be trained and certified by UNTHSC at least every three years in accordance with regulations.

j. Keep track of all Authorized Users (AU).

k. Conduct a formal review and audit at least once a year to ensure that the Radiation Safety Program is being implemented as required by regulations. The evaluation will include equipment, procedures, dosimetry records, inspection findings, and incidents. Each audit report will be kept on file for three years from the date of review.

When radioactive materials are lost, stolen, or damaged, the RSO will be the point of contact for the Texas Department of State Health Services.

The Radioactive Materials License and the Texas Department of State Health Services, which oversees the use of X-ray equipment, both require that all records be kept for a specific period or permanently.

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3.6 Authorized Users and Personnel

In order to reduce their occupational radiation exposures, all personnel who work with radiation sources will adhere to ALARA principles and best work practices. They will use TIME, DISTANCE, and SHIELDING to keep exposures ALARA. In other words, reduce the amount of time spent close to radiation sources when working or doing so nearby, increase the distance, and use shielding. Every authorized user shall, but not limited to:

a. Ensure that radioactive materials are only used as described in HSC's radioactive license and that no unauthorized radioactive material or equipment is used.

b. Follow radiation safety protocols and regulations.

c. Maintain exposure levels as low as reasonably achievable (ALARA).

d. Keep accurate inventory and utilization records.

e. Report any anticipated overexposures.

f. Notify the RSO if a member of the team wishes to declare pregnancy.

g. Ensure that all radioactive waste is disposed of properly.

h. Ensure that all radioactive materials are stored safely and securely.

i. Ensure that all necessary surveys and wipe tests are carried out.

j. When radioactive materials are in use, conduct daily contamination surveys.

3.7 Become an authorized user

HSC faculty members may apply to the RSC for permission to become authorized users of radioactive materials. Such an application consists of the following items:

1. A memorandum addressed to the RSC requesting permission to become an authorized user of radioactive materials. This memorandum should briefly list the isotopes to be used, the quantities to be kept on hand, and the general nature of the experiments. Describe the radiation detection devices you possess or will acquire to ensure worker safety. Also, include the room numbers of laboratories in which radioactive materials are to be used and stored. The memorandum should be sent to the office of the RSO.

2. A Curriculum Vitae

3. A brief history of previous experience with radioactive materials including undergraduate, graduate, and postdoctoral use. Indicate which isotopes and whether experiments were generally in the microcurie range or in the millicurie range. Estimate, if possible, the total amount of each isotope for which you have experience. Also indicate the general nature of the experiments conducted—in vitro assays, short or long-term in

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vivo experiments in an animal model, etc. Also, state if you have documented radiation safety training. If so, list when trained and where.

The RSC will review this packet of information and recommend applicants to the Bureau of Radiation Control to become authorized users under the institution's specific radioactive materials license. The RSO will forward packets of information to the Texas Department of State Health Services Division of Radiation Control for further review and approval or denial.

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4. LICENSE REQUIREMENTS

Texas Department of State Health Services has granted HSC licenses to obtain, use, and store radioactive material, according to license requirements. The use of X-ray-producing equipment, such as fluoroscopy, CT, accelerators, and other devices that emit ionizing radiation, is also governed by Texas's Bureau of Radiation Control (BRC).

The University's licenses are maintained by the Environmental Health and Safety (EH&S), which is also in charge of making sure that licensed materials and other radiation-producing equipment are used in accordance with all applicable regulations, laws, rules, and procedures. State of Texas Application for Radioactive Material License, Appendix A.

The BRC has the power to conduct licensee inspections and cite license holders for infractions. These fines, license restrictions, and license suspensions may be attached to citations.

In compliance with 25 TAC 289.201 (e), the Radiation Control Program under the Department of State Health Services **has the power to conduct licensee inspections and cite license holders for violations/infractions §289.201(i). These fines, license restrictions, and license suspensions may be attached to citations.**

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5. TRAINING

All project personnel must become certified with the rules and regulations relating to the use of radioactive material as reported in this manual before any project using sealed or unsealed sources of radioactive material or equipment is started. All personnel handling radionuclides or other ionizing radiation sources must familiarize themselves with a copy of this radiation safety manual.

The working space and equipment will be determined to be sufficient for the project after the completed application has been reviewed by the RSC. Additionally, each user is required to submit a Statement of Training and Experience Form (Appendix II), which certifies to the RSC that they have received training in radiation fundamentals and handling techniques.

All employees who work with radioactive materials and machinery that emits radiation will receive training. The fundamental concepts and procedures of radiation protection will be covered in the radiation safety course. The course will also cover the use of radioisotopes, radioactive waste management, the theory and measurement of radioisotopes, and the biological effects of radiation.

Based on their use of radioisotopes and their potential for exposure, the RSO will decide what training is required for the individuals. **General Radiation Safety Training is provided by EH&S prior to the commencement of any radiation activity on the UNTHSC campus.** Link to the online radiation safety training is available at EH&S webpage under Radiation Safety.

5.1 Training Frequency

The following conditions will be used during training:
a) Prior to starting work with or near radioactive materials (for users and employees with a certain level of awareness).

b) Whenever there is a significant modification to the obligations, rules, or license terms (for users and awareness-level workers).

c) Regular user refresher training. Every year, refresher training will be required.

5.2 Training Subject/Topics

Depending on the individual's use of radioisotopes and potential for exposure, topics may include all or some of the following:

5.2.1 Radiation safety

Radiation vs. contamination
Internal vs. external exposure
Biological effects of radiation
ALARA concept

Use of time, distance, and shielding to minimize exposure

5.2.2 Regulatory requirements

RSO
Material control and accountability
Personnel dosimetry
Radiation safety program audits
Transfer and disposal
Record keeping
Surveys
Postings
Labeling of containers
Handling and reporting of incidents or events
Licensing and inspection by NRC/Bureau of Radiation Control
Need for complete and accurate information
Employee protection
Deliberate misconduct

5.2.3 Additional licensee-specific program elements

It might also be necessary to cover additional licensee-specific program components, which could include all or some of the following:

a) Authorized users: This includes control procedures for obtaining permission to use radioactive materials at the facility, as well as limits on the amount of radioactive materials handled per user and allowed per experiment.

b) Ordering and receiving radioisotopes: This includes, if applicable, instructions for transferring licensed materials between rooms, halls, or buildings.

c) Any applicable regulations and license terms.

d) Areas where radioactive materials are used or stored: This includes storage requirements, container labeling, and identification of areas where licensed materials are used.

e) Potential radioactive material hazards in each area where the individuals will work.

f) Appropriate radiation safety procedures: This includes reviewing required protective clothing, laboratory attire, and equipment. Pipetting by mouth, eating, smoking, and drinking are all prohibited in areas where licensed materials are used.

g) The licensee's internal work rules.

h) Each individual's responsibility to notify the RSO of any unsafe conditions.

i) Prompt response to spills, emergencies, or other hazardous conditions.

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j) The right of workers to be informed about occupational radiation exposure and bioassay results, if applicable.

k) Locations where the licensee has posted or made available notices, copies of relevant regulations, and copies of relevant license and license conditions (including applications and applicable correspondence), as required by 10 CFR Part 19 "Notices, Instructions, and Reports to Workers: Inspection and Investigations."

l) RSO name and phone number; immediate steps to prevent or control contamination spread; clean-up instructions; and decontamination are all part of the emergency procedures.

m) Survey program
- i. Access to survey instruments
- ii. Who is responsible
- iii. Types, contamination, and area
- iv. Frequency
- v. Levels of contamination
- vi. Personnel, hands, and shoes
- vii. Records

n) Waste
- i. Liquid
- ii. Solid
- iii. Sanitary sewer
- iv. Burial (transfer to low-level waste repository)
- v. Storage
- vi. Decay-in-storage
- vii. Waste storage surveys
- viii. Records

o) Dosimetry
- i. Whole body
- ii. Extremities
- iii. Lost or replacement badges and dose assessment
- iv. Bioassay procedures
- v. Records

p) Instrumentation, such as survey meters, calibration frequency, and use of check sources; analytical instruments, such as liquid scintillation counters, and radiation-producing machines

q) Procedures for receiving radioactive materials-containing packages
- i. Normal

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ii. Off-duty
iii. Notification of user and RSO
iv. Security
v. Exposure levels
vi. Possession limit
vii. Receipt of damaged packages

r) Package opening and examination procedures
i. Leakage and contamination
ii. Monitoring packages
iii. Monitoring packing materials
iv. Gloves
v. Transferring material to users

s) Sealed sources
i. Leak test requirements
ii. Inventory requirements
iii. Exempt quantities
iv. Records

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6. ACQUISITION OF RADIOACTIVE MATERIALS

The "Application for Possession and Use of Radioactive Material or Equipment" Form, (sample Appendix III of this manual), accessible from the EH&S website is used to submit requests for the purchase and procurement of radioactive materials and equipment. In order for the RSC to review the proposal before approving it, requests are sent to the Committee via the RSO and must be sufficiently detailed.

The applicant must include a protocol for their experiment or detail in their application any clinical or experimental practices or actions that could have an impact on or result in the unintentional release, ingestion, or inhalation of radioactive material. Any potentially dangerous substances or compounds that will be employed should also be mentioned by the applicant. Sample of general radiation related protocol guideline is available in Appendix IV. Safety Data Sheets and other relevant information are available at the last Appendix (Appendix XXVIII) to serve as guidelines for appropriate use.

Applications that have been approved remain valid for their entire lifespans, but they must be evaluated annually to ensure that the current inventory is accurate. After completion of work relating to radiation, applicants will arrange with the RSO for the transfer or disposal of any radioactive material or equipment that is still in their possession.

The Committee has authorized the RSO to permit and accept routine applications in order to expedite the approval of the majority of applications. The following specific uses are required to be evaluated and approved by the Committee because they are considered to be significant.

a). Applications for the purchase of isotopes with a class I hazard of more than 100 microcuries and a class II hazard greater than 1 millicurie.

b). Applications for studies or tasks involving sizable airborne dangers from gases, fine particles, or aerosols

c). Applications for ionizing radiation-using facility new installations or significant changes to current installations.

d). Other proposals for usage that the RSO believes ought to be brought to the whole Committee's consideration

Applications in the aforementioned categories should be submitted well in advance of the anticipated start date because it will typically take two to four weeks to convey emergency Committee meetings to meet and examine them.

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6.1 Radionuclide Classification Based on Relative Hazard Potential

When evaluating an application, these categories assist in identifying the type of laboratory or workplace requirements that are required. The toxicity ratings in Appendix V were derived from

a variety of published sources, but they may have been adjusted upward or downward if local conditions warranted it in the expert opinion of the health physicist.

6.2 Amendment

Every modification to an existing permit must be sought in writing to the RSO and include a completed Permit Amendment form (Appendix VI). For modifications to the radionuclide, possession cap, usage location, protocol, or addition or deletion of specific users, an amendment to the original investigator's authorization is necessary.

6.3 Procurement

Authorized Users are responsible for following proper administrative procedures when ordering radioactive materials. All orders require the prior consent of the RSO. All radioactive materials must be delivered to the RAM-approved lab after being received by RSO and Staff. Authorized users may not use a procurement card to purchase radioisotopes. Users must order radioactive materials through the requisition process in Market Place system. For Market Place requisition orders, the item's single-line description must include the catalog number, isotope name, chemical name, and radioactive quantity (each). The requester for AU department will need to submit the requisition in Marketplace and attach the quote, the requisition will route for approvals based on the category code (193-80).
To have your radioactive materials order routed automatically to the RSO and his staff for approval, you must use one of the following goods category codes given in Table 6.1.

Table 6.1: Description of input codes for Market Place radioisotope order

Goods Category	Description
193-80	Radioactive chemical
269-78	Radioimmunoassay Kits

Market Place requisition that are approved by the account holder flow to the Safety Office for RSO approval. Either the RSO or the assistant RSO acting on behalf of the RSO may electronically approve the order. If for some reason Market Place requisition becomes unavailable due to emergency or disaster situations, the Purchasing Department will notify Market Place users of alternative methods for submitting radioactive material orders. If possible usage of Appendix VII. Orders are routinely approved for all authorized users who maintain a good safety record and compliance with regulations and established procedures, provided the amounts ordered are considered normal and routine. Suppose an authorized user wishes to order quantities of radioactive material that are well above those routinely ordered by that user. In that case, the RSO will consult with the authorized user regarding the order. The RSO will determine that the authorized user has a genuine need for such material and that adequate shielding and technique ensure worker safety. If the authorized user and RSO cannot agree, the matter will be referred to the Radiation Safety Committee. The committee shall make the necessary

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determinations if needed and the adequacy of procedures in consultation with the authorized user and the RSO. Such decisions shall not violate any part of state regulations governing radioactive material.

6.4 Receiving

The Authorized User shall receive all packages and inspect them for leaks, leaking of contents, and package integrity. Radioactive packages can only be accepted by RAM-trained users. To record the state of the package, the Appendix VIII form needs to be completed. The Authorized User must promptly send the completed Appendix VIII to the RSO and amend their inventory log to reflect the new shipment.
All radioactive materials must be shipped to the RSO at the following address from vendors or other licensees:

Radiation Safety Officer
UNT Health Science Center Central Receiving
3420 Darcy Street
Fort Worth, Texas 76107

All radioactive materials must be picked up from Central Receiving, unopened, and transported to the RSO's laboratory for check-in by Safety Office personnel. RSO personnel will inspect packages for damage and perform any necessary wipe tests. Copy of Appendix VIII must be completed and kept on record. **All packages are inspected by the RSO in accordance with 25 TAC 289.202(ee). This inspection, however, is limited to the box's external surface, with a check of the inside of the outermost container. The majority of packages are constructed with three levels of containment (Figure 6.1).** The checked radioactive material will be delivered to the authorized user's laboratory by the RSO or a qualified member of the Safety Office staff. Special instructions for Central Receiving and Campus Police personnel can be found in Appendix IX.
When materials are received, receiving records shall be photocopied and affixed to the requisition. These ordering and receiving records shall be kept on file in the RSO office for two years and made available to inspectors from the Bureau of Radiation Control.

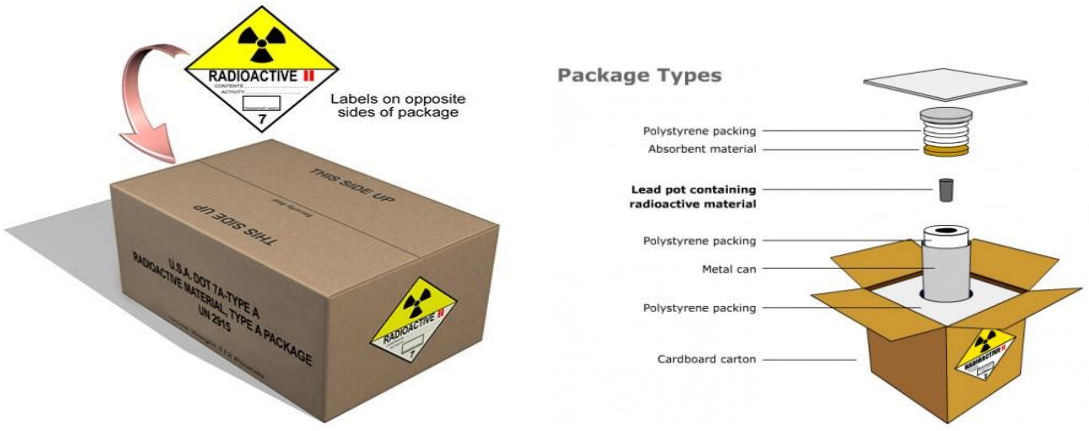

Figure 6.1: Radioactive package and 3-levels of containment

All packages shall be inspected in compliance with 25 TAC 289.202(ee). For those packages that are exempted from wipe test requirements under this rule and which contain either gamma-emitting material or ^{32}P or ^{35}S, the RSO shall use a Geiger counter with a low energy scintillation probe (Ludlum 14C with a 44-3 probe or equivalent) to check for overt leakage inside the outermost container. No written record of such additional inspections is required unless contamination is detected. Reports of leaking packages shall be made in accordance with 25 TAC 289.202(ee).

6.5 Delivery

All radioactive materials must be logged into the authorized user's radioisotope running inventory on the same day they are delivered to the user's laboratory. Appendix XII of this manual contains a copy of the form for this purpose. It should be replicated as necessary. For each primary container of radioactive material received, one log sheet must be completed. If you receive one bottle of radioactive material containing 5 mCi, for example, you should fill out one inventory sheet. If, on the other hand, you receive five 1mCi bottles, you must complete five log

sheets, one for each primary container. Log sheets and isotope boxes must be labeled so that log sheets and containers can be easily matched.

Authorized users and their staff must thoroughly inspect radioactive material containers. The RSO's survey would not detect a leak at this level, so authorized users should exercise caution when opening the second and third inner packages. Authorized users must immediately report leaking inner packages to the RSO for follow-up.

6.6 Transfers

Any sealed or unsealed source of radioactive material that is being transferred from one licensee to another, on or off campus, must be reported to the RSO. The RSO must receive the "Radioactive Material Transfer Form" (Appendix X) for approval before a transfer is done. To guarantee that the receiver of the radioactive material is approved by the RSO and state, the RSO must be notified before the location of any sealed or unsealed radioactive material is altered. U.S. Department of Transportation regulations must be followed while moving radioactive materials off campus. All low-level radioactive material or trash shipments must be examined by the RSO or a trained designee. The Bureau of Radiation Control must be notified 48 hours in advance of shipping low-level radioactive waste off-campus.

The U.S. DOT Hazardous Material regulations must be followed by all individuals managing shipping or transportation activities for radioactive material that are governed by Title 49, Code of Federal Regulations. Training must be finished within 90 days of employment, and refresher training is required every three years. Training certificates must be kept on file permanently.

6.7 Facilities

From the standpoint of radiation safety, radioactive materials or producing equipment are not to be used in any University facility without the approval of the RSC and/or the RSO. Prior to the

construction or modification of the premises, plans for all new buildings and reconstruction of existing structures containing radioactive materials or equipment must be approved by the RSC. The RSC must be notified prior to the termination of radionuclide activity or radioactive-producing equipment to ensure that the facility is free of contamination and that the transfer material is in accordance with regulations.

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7. OCCUPATIONAL DOSE LIMITS AND PERSONNEL MONITORING

At HSC, we are committed to the concept of personnel radiation exposure being as minimal as possible and therefore adhere to the as low as reasonably achievable (ALARA) practice (TAC 289.202 (e)(2). The following rules must be followed at HSC at all times:

7.1 Radiation Employees Dose Restrictions

Because any radiation exposure is undesirable, it is critical to keep all exposures to the lowest level reasonably possible. The UNTHSC's permissible ALARA radiation dose levels are more conservative than the state or federal regulations (Table 7.1), and they are listed below (Table 7.2). Employees are required to regularly assess their work practices and accessibility of safety equipment to ensure compliance with the ALARA principle and applicable State laws. The RSO will inform the affected parties when personnel exposures exceed ALARA limitations. The RSC will look into and evaluate these exposures. Any person who received a dose greater than UNTHSC Level I (Table 7.2) in any calendar quarter will be investigated by the RSO.
The State and Federal dose of radiation to minors and embryos/fetuses must not exceed 10% of the following limits (0.5 rem (5 mSv) for a whole-body dose). However, UNTHSC's permissible ALARA radiation dose levels to minors and embryos/fetuses must not exceed 10% of what is stated Table 7.2.

The annual total effective dose equivalent 25 TAC 289.202 (f) in Table 7.1 shall not be exceeded for any employees working with radiation.

Table 7.1: The annual total effective dose equivalent

The annual limits shall be less than values below	
the total effective dose equivalent being equal to 5 rems (0.05 Sv)	a lens dose equivalent of 15 rems (0.15 Sv)
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 is equal to 50 rems (0.5 Sv)	a shallow dose equivalent of 50 rems (0.5 Sv) to the skin of the whole body or to the skin of any extremity

Table 7.2: UNTHSC Radiation Dose Limits

	Level I	Level II	Level III
Total Effective Dose Equivalent (whole-body; or	125 mrem (1.25 mSv)	375 mrem (3.75 mSv)	1250 mrem (0.0125 Sv)
Sum of deep dose equivalent and the committed dose equivalent to any organ of tissue other than the lens of the eye	1250 mrem (1.25 mSv)	3750 mrem (0.0375 Sv)	12500 (0.125 Sv)
Lens of the eye (eye dose equivalent)	375 mrem (3.75 mSv)	1125 mrem (0.01125 Sv)	3750 mrem (0.0375 Sv)

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Skin (shallow dose equivalent or to any extremity	1250 mrem (0.0125 Sv)	3750 mrem (0.0375 Sv)	12500 mrem (0.125 Sv)
Embryo/Fetus	11.5 mrem	34.5 mrem	115mrem

7.2 Pregnant worker

It is recommended that a pregnant employee notify her employer in writing of her pregnancy and the anticipated conception date by reporting to RSO via their supervisors and completing a copy of Appendix XI. When a pregnant employee reports her pregnancy, the licensee must make sure that the dose that would be received by an embryo or fetus during pregnancy owing to a declared pregnant employee's occupational exposure does not exceed 0.5 rem (5 mSv) in compliance with state regulations and laws.

In order to comply with the limits stated by regulations and laws, the licensee must take precautions to prevent substantial deviation above a uniform monthly exposure rate to a declared pregnant employee. The National Council on Radiation Protection and Measurements (NCRP) and other regulatory bodies recommended that no more than 0.05 rem (0.5 mSv) of radiation exposure to the embryo or fetus be given in any given month during pregnancy.

If the dose equivalent to the embryo/fetus has exceeded 0.45 rem (4.5 mSv) by the time the employee informs the licensee of the pregnancy, the licensee will be deemed in compliance with state regulations and laws if the additional dose equivalent to the embryo/fetus does not exceed 0.05 rem (0.5 mSv) for the remainder of the pregnancy. The pregnant employee shall be assigned a workstation that minimizes the risk of radiation exposure to the fetus. The radiation exposure will be closely monitored.

7.3 Individual Members of the Public Dose Restrictions

In order to limit the total effective dose equivalent to individual members of the public (non-radiation workers), a licensee must demonstrate compliance with the yearly dose cap by proving that the radiation exposure from the unrestricted area would not exceed 0.002 rem (0.02 mSv) per hour and 0.05 rem (0.5 mSv) per year.

At the unrestricted area's boundary, the annual average concentrations of radioactive material released in gaseous and liquid effluents do not exceed 10 percent of the values specified in Table II of §289.202(ggg)(2)(F) (https://www.dshs.texas.gov/sites/default/files/radiation/pdffiles/Rules/289-202b_3-2016.pdf)

7.4 Personnel Monitoring and Dosimetry

UNTHSC radiation users' employees' individual radiation exposure to gamma, X-ray, and energetic beta sources must be monitored by the RSO. All monitoring equipment must be purchased and provided from EH&S by the RSO. A clip-on badge (full body film badge or thermoluminescent dosimeter [TLD]) or ring badge with the wearer's name, the date of the monitoring period, and a special identifying number is the most common monitoring dosimeter. Each individual monitoring device must be processed and evaluated by a dosimetry processor who is currently accredited by the National Voluntary Laboratory Accreditation Program

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(NVLAP) of the National Institute of Standards and Technology as a personnel dosimetry processor, and who has been approved during this accreditation process for the type of radiation or types of radiations included in the NVLAP program that most closely resemble the type of radiation or types of radiation the individual wears.

7.5 Request for radiation monitoring badge

Individuals who require a radiation dosimeter should complete in entirety the "Request for Radiation Badge" link available on the EH&S webpage under Radiation Safety (copy of Appendix XV) and send it to the RSO. The RSO will issue a temporary badge and will order a permanent badge with the worker's name. When the badges are ready, prospective requestor will be informed and they can be picked up from the RSO's office.

7.6 Location and usage of individual monitoring badges

Individual monitoring equipment used to track the dosage to the body must be worn in areas of the body that are not shielded and are most likely to be exposed to radiation. The individual monitoring device is usually worn at the neck when a protective apron is used (collar).

If an extra individual monitoring device is used to track the dose given to an embryo or fetus of an employee who has declared pregnant in accordance with state regulations and laws, then it must be placed at the employee's waist beneath any wearing protective clothing. Individual monitoring devices used to demonstrate compliance shall be located at the neck (collar) or closer to the eye, outside any protective apron being worn by the monitored individual.

To demonstrate compliance with state regulations and laws, an individual monitoring device used for monitoring the dose to the skin of the extremities shall be worn on the skin of the extremity likely to receive the highest exposure. To the greatest extent possible, each individual monitoring device must be oriented to measure the highest dose to the skin of the monitored extremity.

Only one individual shall be assigned to and wear an individual monitoring device.

Depending on the location where the monitoring device is being worn and the anticipated radiation exposure, each film/TLD badge must be given to and worn by just one person. It must be changed at most every three months.

The RSO is in charge of making badge deliveries, exchanging them, and picking them up.

The RSO shall be responsible for ensuring that each monitoring device is delivered to the dosimetry processor in the correct state for processing.

The RSO shall be responsible for making sure that sufficient measures are implemented to prevent the false exposure of specific monitoring equipment.

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If an employee is issued an extremity dosimeter (ring TLD), it must be worn on a finger under a glove with the sensitive part of the device facing the palm of the hand, or the area closest to the radiation source, to prevent the finger from shielding the dosimeter from radiation.

Wear the ring dosimeter on your finger with the sensitive part facing the radiation source if you're working with other radiation sources, such as x-ray diffraction machines. When necessary, ring dosimeters must be worn with gloves on to avoid contaminating the instrument.

7.7 Lost or damaged personnel monitoring device

If an individual's current occupational dose data for the current year are insufficient (due, for example, to a lost or damaged personnel monitoring device) and that individual works solely for the licensee during the current year, the licensee shall: (A) assume that the person's allowable dose limit is decreased by 1.25 rems (12.5 mSv) for each quarter; (B) assume that the person's

allowable dose limit is decreased by 416 mrem (4.16 mSv) for each month; or (C) estimate the individual's occupational dose during the period of missing data using surveys, radiation measurements, or other comparable data in order to show compliance with the occupational dose limits.

The Investigator or employee is responsible for immediately informing the RSO of any monitor damage, loss, or exposure so that the monitor can be replaced or processed. EH&S keeps a permanent record of monitor readings.

Dosimeters must only be used in accordance with instructions because their recordings are presumed to be proof of individual exposures under the law. When it seems to be in the best interests of HSC, the RSC or RSO may mandate the use of dosimetry in circumstances that typically wouldn't warrant it.

Each person who anticipates using ionizing radiation is required to give the RSO a copy of his occupational exposure record for all radiation exposures he had prior to enrolling at HSC. To avoid contamination, workers with radioisotopes may be compelled to wear protective clothing.

7.8 Precautions for Dosimeters

A dosimeter must be stored away from radiation sources when not in use.
A dosimeter must be protected against contamination (e.g. wear finger rings under gloves, etc.)
A dosimeter must not be used without an appropriate badge holder.
A dosimeter must not be worn without the printed information facing away from the part of the body where the highest dose is expected.
UNTHSC-issued dosimeter must not be worn at any facility other than HSC.
A dosimeter must not be intentionally exposed to radiation, to just "test" it.
If a dosimeter is no longer needed, it must be returned to the RSO. It must not be disposed of.
A dosimeter must not be punctured/cut with staples, scissors, tacks, etc.
A dosimeter must not be exposed to hazardous chemicals, liquids, or excessive heat.
A dosimeter must not be loaned to anyone. DO NOT borrow anyone else's badge.

8. SIGNS AND LABELS

8.1 Restricted Area

A "Caution Radioactive Material" or "Caution High Radiation Area" (Figure 8.1a, b, & c) sign, a "NRC Licensing and Regulation Information Bulletin" sign, and a "Notice To Workers" (Appendix I) sign must be displayed in any rooms or locations where licensed quantities of radioactive materials or radiation equipment are used or stored.

a 

b 

c 

Figure 8.1a, b, and c: Radiation area caution signs

The Authorized User's name, phone number, and emergency contact information must be displayed on door signs. You can get postings from the RSO.

Restricted Area Definitions 25 TAC 289.201 (10 CFR 20.1003)

8.1a Unrestricted area (uncontrolled area) - An area or access to which the licensee does not limit or control. "Uncontrolled area" is an equivalent term for the purposes of this chapter.

8.1b Restricted area - An area to which the licensee restricts access in order to protect individuals from undue risks from radiation exposure. Restricted areas do not include residential quarters, but separate rooms within a residential building may be designated as restricted areas.

8.1c Controlled Area - An area outside of a restricted area but within the site boundary, to which the licensee may restrict access for any reason.

1. **Radiation area**--Any accessible area in which radiation levels could result in an individual receiving a dose equivalent to more than 0.005 rem (0.05 mSv) in one hour at 30 cm from the source of radiation or from any surface through which the radiation penetrates.

2. **High radiation area**--An area accessible to individuals where radiation levels from external sources of radiation could result in an individual receiving a dose equivalent in excess of 0.1 rem (1 millisievert (mSv)) in one hour at 30 cm from any source of radiation or any surface through which the radiation penetrates.

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3. **Very high radiation area**--An area accessible to individuals in which radiation levels from external sources of radiation could result in an absorbed dose in excess of 500 rads (5 Gy) in one hour at 1 meter (m) from a source of radiation or from any surface through which the radiation penetrates. Units of absorbed dose, gray and rad, rather than units of dose equivalent, Sv and rem, are appropriate for very high doses received at high dose rates.

The majority of the radiation-use areas on the UNTHSC campus are controlled as restricted areas. Members of the public are welcome to attend as long as they are escorted by a trained worker or have been trained in radiation safety to work independently. Authorized User training meets the training needs of workers who visit the laboratory but do not handle radioactive materials.

To ensure that there are no significant exposure levels of any form of radiation, strict surveillance must be maintained within the restricted area.

Other radiation area restriction categories (radiation area) do not currently exist on campus. Any of the restricted areas may be restricted to a higher level of security in an emergency or other unusual circumstance to safeguard against radiation or any other potential hazards. The area(s) would be clearly marked and posted with warning signs or barriers if this happened.

8.2 Labeling Requirements

Workspaces, trays, racks, stock solutions, tools, equipment, etc. that are contaminated or contain radioactive material need to be marked with radioactive materials tape or a "Caution Radioactive Materials" sign. The radioisotope present, the date, and the overall activity in disintegrations per minute (DPM) or microcuries must all be listed on the label. Although it is not reasonable to anticipate that every tube or vial will be labeled, the container, tray, or rack that holds them must be marked. Scintillation vials, for instance, do not need to be individually labeled; however, the tray or box that they are stored in must have the label mentioned above.
The "rule of thumb" is that anything that has radiation in it or on it above background levels needs to be labeled.

1. The radioactive warning label for contaminated equipment that is frequently used must include the isotope, date, and maximum activity that may exist at any given time.
2. A label reading "Caution, Radioactive Materials" may be applied to equipment that is used for radioactive materials but is not contaminated (equipment that the staff wishes to identify for radioactive use).
3. If the equipment is not contaminated, no labels are required.

All radioactive waste must be labeled in a similar manner with the information mentioned above.

The same style of labeling must be used for benchtop waste containers as it is for radioactive materials that are being used or stored.

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All information on the waste tag needs to be completed before radioactive waste can be put in the radioactive waste container.

Labels Used on Radioactive Materials Packages

Standard size is approximately 4 inches x 4 inches.

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

Figure 8.2: Radioactive material package labels

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9. INVENTORY AND STORAGE

Each investigator or supervisor is responsible for providing the RSO with quarterly radioactive material inventory reports. The investigator or supervisor must keep inventory records on file for the RSC and DSHS/Radiation Control inspectors to review. EH&S has inventory record forms available.

To confirm registration with DSHS, the RSO will conduct an annual physical inventory of all radiation-producing equipment. It is the responsibility of each authorized user, principal investigator, or supervisor to inform the RSO/RSC of any changes that would make the registration inaccurate. Examples of such information include relocation, change of use, sale, transfer, or disposal of any radiation machine or a substantial portion thereof.

9.1 Storage

Waste and radioactive materials must be kept in containers that offer sufficient shielding for the isotope being kept. Waste and radioactive materials need to be stored separately based on the isotope.

Radioactive material must be kept in properly labeled fume hoods, cold rooms, refrigerators, and freezers. All refrigerators, cold rooms, and freezers used to handle or store radioactive material will have signs posted by the RSO warning that no food or beverages should be kept inside. Unless under the direct supervision of an approved worker or an authorized user, radioactive materials must be stored in a secure location.

Volatile radioactive materials must be kept (and used) in a glove box or fume hood that is in good working order and has an exhaust to the outside atmosphere.

To reduce the risk of breakage, liquid radioactive material should be stored in durable plastic containers rather than glass. The container's lid must screw on. Containers for beverages shouldn't be used. The contents of the container, including the isotope and chemical components, should be listed on the label.

9.2 Radioactive materials running inventory

When radioactive materials are removed from their primary containers, authorized users and their staff must log radioactive material out of their current inventory. The inventory must be kept in Ci or mCi units. Volume quantities may be indicated on logs, but they must NOT be used for isotope inventory. When radioactive material is received from the RSO, all information about its receipt at the top of the running inventory must be completed. Appendix XII of this manual contains a copy of this form.

9.3 Radioactive materials quarterly inventory

Authorized users must prepare a decay-corrected inventory of all radioactive materials purchased, used, and remaining activities once in every calendar quarter. Furthermore, users

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must report the quantities of radioactive materials transferred to the RSO for disposal. This form can be found in Appendix XIII of this manual. Inventories are due at the start of each quarterly meeting of the RSC. Authorized users will be notified of such meetings in advance, and they will have at least one week to prepare inventories. Users should keep a copy of the inventory for their logbooks, while the RSO will keep one.

9.4 Monthly wipe tests

During any calendar month, authorized users and their staff must conduct wipe tests in all restricted areas under the authorized user's control where radioactive material is used. Monthly wipe test documentation must be submitted to the RSO on time. Wipe tests or documentation of no use during the calendar month are due on the first working day of the following month and are considered timely if received in the Safety Office by the close of business on the third working day of the following month. Refer to Appendix XIV for monthly area survey procedures and sanctions.

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10. CONTAMINATION SURVEY

"Survey" refers to an assessment of the radiation hazards associated with the use, release, disposal, and presence of radioactive materials and other sources under the supervision of a specific Authorized User. A survey should include measurements of external radiation levels near sources in use, storage, waste containers, and so on, as well as wipe testing for removable contamination. It is necessary to include both restricted and adjacent unrestricted areas. In order to alert laboratory personnel to potential hazards, routine laboratory surveys are required in research, clinical, and teaching laboratories to detect excessive radiation levels and/or contamination.

10.1 Survey frequency

After each use of radioactive material or at the end of the day, the laboratory must be inspected for contamination. One such survey must be recorded at least WEEKLY. This is the bare minimum; more frequent surveys (where appropriate) are encouraged. The frequency of survey for some radioisotope are listed in Table 10.1. Contamination surveys are not required during times when no radioactive materials are used.

Table 10.1: Survey frequency

Radiation Type	**Examples**	**Survey Frequency**
Beta <200 KeV	^{3}H, ^{14}C	Weekly
Beta >200KeV	**^{32}P, ^{33}P**	Daily
Gamma	**^{125}I**, ^{131}I,	Daily

10.2 Method of Survey

A variety of methods can be used to conduct contamination surveys. "Area" and "wipe" surveys are the two most common methods.

i). Area Survey: A portable radiation survey meter is used to measure both fixed and removable contamination. Meter surveys using Geiger detectors or scintillation probes can detect gross contamination (total contamination that includes both fixed and removable contamination), but only certain isotopes can be detected.

ii). Wipe Survey: This method measures only removable contamination by wiping a surface with a small "wipe" and counting the wipe with an appropriate counting device.

It is critical to choose and use a contamination detection instrument suitable for the type of radioactive material being used.

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Table 1 0.2: Radioisotope contamination survey techniques

Radioisotope	Acceptable Survey Technique	Comment
^{3}H	LSC	There are no other acceptable survey methods
^{14}C	G-M or LSC	LSC is the most sensitive; G-M detects moderate to high levels of contamination; do not use parafilm on G-M.
^{51}Cr	NaI, g, or LSC	
^{64}Cu	LSC	
^{18}F	G-M or LSC	LSC is the most sensitive
^{32}P	G-M or LSC	G-M detects low levels of contamination
^{125}I	NaI, g, or LSC	Gamma is the most sensitive
^{137}Cs	LSC, g	LSC is the most sensitive

*G-M = Geiger-Muller detector survey meter. LSC = liquid scintillation counting. NaI = survey meter equipped with a thin crystal sodium iodide detector. g = gamma counter.

10.3 Organizing the Survey

It is critical to avoid contaminating yourself and/or the survey equipment when conducting contamination surveys. Among the methods are the following:

a. Area survey

A Geiger-Muller (G-M) detector is the most typical survey instrument that will be used at HSC. The high energy beta emitter ^{32}P and other high energy beta and gamma emitters like ^{60}Co, ^{65}Zn, ^{137}Cs, and ^{238}U are the best candidates for the portable G-M survey meter. Additionally, since the G-M meter has a relatively low efficiency for lower energy betas like ^{14}C or ^{35}S, it can be used to locate areas that are heavily contaminated with these particles. Since G-M meters will only detect ^{125}I when there are extremely high levels of contamination, they should not be used to survey for ^{125}I contamination.

In order to find ^{125}I contamination and to perform surveys near low-energy X-ray sources like X-ray diffractometers and electron microscopes, one can use a portable thin crystal NaI scintillation survey meter.

The most flexible counting instrument is the liquid scintillation counter, which is used for counting wipe tests and has a high counting efficiency for a variety of radionuclides despite not being portable.

Gamma counters, which are used to count wipe tests for photon emitters like ^{51}Cr or ^{125}I, are not portable.

a. i Meter Survey Techniques

Turn the meter knob to the battery test position to check the survey meter's battery. The meter needle will swing to the battery test position on the meter face if the battery is sufficiently charged. If the batteries are running low, replace them.

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Perform an operational check on the meter the first time you use it each day or whenever you suspect it has been misused or damaged. Examine the calibration sticker on the side of the meter and make a note of the expected reading for the operational check source. Turn on the meter and set the multiplier switch to a setting that will measure the check source and provide a mid-scale reading while preventing the needle from swinging beyond full scale. Place the probe firmly against the check source on the meter's side and record the meter's response. If the observed meter response differs by more than 20% from the expected response, the meter should be considered nonfunctional and removed from service.

Take the meter to an area away from sources of radiation and note the meter background reading. A G-M meter with a pancake survey probe should typically have a background reading of less than 100 counts per minute (cpm), whereas a meter with a NaI scintillation crystal should have a background reading of less than 300 cpm. If the meter's background reading is significantly higher than expected, make sure there are no unexpected sources of radiation or radioactive materials nearby before reporting a contaminated meter to EH&S.

Do not use parafilm or any other protective covering on the probe surface. Parafilm and other similar materials will protect the low energy betas from C-14, P-33, and S-35, preventing the meter from detecting contamination.

Move the probe slowly about 1 centimeter above the area of interest.

If an item or area is discovered with a sustained count rate greater than three times the background, the item or area should be considered contaminated.

Label the area or item immediately and decontaminate it as soon as possible.

The meter survey can be ambiguous at times, especially in the presence of other radioactive materials. When the meter survey indicates that low-level contamination is possible, a wipe survey should be performed to confirm or deny the presence of contamination.

Record the survey results whenever contamination is discovered or when 250 µCi or more is handled. Fill out the Area Survey Report with survey results. This is a requirement of the university.

b. Wipe Surveys

Wipe surveys are required when ^{3}H is used and are the preferred survey method for detecting the presence of low levels of removable ^{14}C, ^{33}P, and ^{35}S contamination. When a meter survey indicates that low-level contamination is present, wipe surveys should be performed to confirm the presence of contamination.

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a. i Wipe survey Technique

Wipe the area being surveyed with a piece of filter paper (about 5 cm2 or 1" in diameter), Q-tip, or other swab. If the area is large, divide it into smaller sections and use multiple wipes to better pinpoint the source of contamination. Some surfaces, such as skin and clothing, require that the wipe media be moistened with water or another appropriate solvent.

Prepare the sample for counting according to the instructions on the counter. Analyze the wipe samples for H-3 and other beta emitters in a liquid scintillation counter and, preferably, ^{51}Cr and ^{125}I in a gamma counter.

Divide the sample count by the counter's efficiency for the isotope in question to calculate sample activity. The operating manual for the counter should include information on efficiencies and activity determination.

If you have any questions about the use of liquid scintillation and gamma counters, please contact EH&S. Decontamination is required if the results exceed 100dpm/100cm^2 or twice the background level.

10.4 Radiation Survey Meters

Calibrated survey meters suitable for the type and level of ionizing radiation used must be available. Every 12 months, survey meters must be calibrated. For instrument calibration and minor repairs, contact EH&S.

10.5 Leak Test

Leak tests will be performed at the following **NRC and DSHS-approved** intervals:

i. List identifying information for each source to be tested, such as the manufacturer, model number, serial number, radionuclides, and activity.
ii. To monitor exposure, use a survey meter if one is available.
iii. For each source, prepare a separate wipe sample (e.g., cotton swab or filter paper).
iv. Each wipe should be numbered to correspond with the identifying information for each source.
v. Wipe the most accessible area (but not the source's surface) where contamination would accumulate if the sealed source were to leak.
vi. Choose an instrument sensitive enough to detect radionuclides at 185 becquerels (0.005 µCi) and ensure that its calibration is up to date.
vii. Count and record the background count rate using the chosen instrument.
viii. Calculate efficiency.
ix. Calculate and record estimated activity in becquerels (or microcuries) for each sample.
x. Sign and date the source, data, and calculation list. Records must be kept for three years (10 CFR 20.2103(a) "Records of Surveys").
xi. Notify the RSO if the wipe test activity is 185 becquerels (0.005 µCi) or higher so that the source can be removed from service and properly disposed of.

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The sealed and foil source(s) must be tested for leakage and/or contamination every 6 months. Any source received from another person that is not accompanied by a certificate indicating that a test was performed within 6 months prior to transfer must not be used until it has been tested.

Despite the periodic leak test mandated by this condition, any licensed sealed source that contains 100 µCi or less of beta and/or gamma-emitting material or 10 µCi or less of alpha-emitting material is exempt from such leak tests. It is not necessary to test any sources that are stored and not in use. The source must be tested before use or transfer when it is taken out of storage to be used or transferred to another person.

The test must be able to identify radioactive material as small as 0.005 µCi on the test sample. The source must be taken out of service and decontaminated, repaired, or disposed of in line with NRC regulations if the test reveals the presence of 0.005 µCi or more of removable contamination. After learning the results of the leak test, a report must be submitted to the NRC within 5 days. The involved source, test results, and corrective action must all be mentioned in the report. Leak test results must be documented and kept on file for NRC inspection in units of microcuries. Documents may be discarded after an NRC inspection.

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11. DECONTAMINATION

Contamination occurs when radioactive material appears in an unintentional or undesirable location. This may include surfaces, tools, workspaces, storage areas, people, or areas outside the laboratory for authorized radiation use. Fortunately, most radioactive contamination and/or spills can be quickly and inexpensively cleaned to background levels. For assistance with any decontamination procedures, get in touch with the RSO.

The isotope, its quantity, and its use will all affect the decontamination procedures. In some cases, it is possible to flush the water and detergent used to clean up work areas and contaminated skin down the sanitary sewer. It might have to be gathered in other circumstances. This will be covered during training and the setting up of the labs for the use of the isotopes to suit the requirements of each radioisotope lab.

11.1 Liquid Decontamination

Most scientific suppliers sell concentrated liquid decontaminating agents. This detergent removes radioactive contamination quickly, easily, and with little effort when diluted with water. The majority of contamination can be removed with this detergent by gently wiping or scrubbing.

The Safety Data Sheet should be read by new radiation users so that they are aware of the risks because these detergents contain a carcinogen. Radioactive decontaminants in diluted liquid form do not pose a serious risk to handlers unless ingested or splashed in the eyes. Limit your time spending near the concentrated material on your skin.

11.2 Foam Spray Decontamination

There are numerous foam spray decontamination items that are marketed as radioactive decontaminants. The majority of these foam cleaning products are sold in any store as bathroom or kitchen cleaners, but many other foam cleaning products achieve decontamination just as effectively and at a much lower price. Spray the foam on the contaminated areas, allow to sit for a short while, and then wipe with a dry paper towel.

11.3 Other Decontamination Agents

To remove radioactive contamination that has proven resistant to the aforementioned techniques, numerous other substances will be used. For help with contamination that is challenging to remove, contact the RSO. He or she will assist in determining the best decontamination technique for your specific surface, nuclide, chemical form, and location. The identification of efficient solutions to the issue will depend on these variables.

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12. ANIMAL HANDLING PROCEDURES

The Institutional Animal Care and Use Committee (IACUC) is in charge of considering proposals for animal use that involve potentially dangerous substances, such as radioactive materials, infectious microorganisms, and hazardous chemicals. Each of these substances can potentially hurt both people who care for and work with animals and the animals themselves.

Federal, state, and local regulations place strict controls on some hazardous materials. The University also has committees looking into the use of biological and hazardous materials in addition to these rules. The professional staff and faculty at UNTHSC have set up specific safety committees that are experienced in handling biological and radiological materials.

The Institutional Biosafety Committee and the RSC are two examples of these committees. EH&S evaluates chemicals for potential hazards. The IACUC anticipates that the relevant safety committee will examine and evaluate any potential risks related to animal use.

It is necessary to reassure the IACUC committee that the proper review and follow-up are being done. This biohazardous and radiological use of animals policy must be fully complied with by the Investigator or Authorized User.

12.1 Radioactive Materials and Sources

The RSO and the IACUC must work together to review any animal research protocol involving the use of particular radioactive substances and X-ray techniques. It is the Investigator's duty to complete the appropriate sections on the animal use protocol form and submit the necessary paperwork to the RSO for review. The IACUC form must have the RSC's final approval attached. Receiving approval from the RSC is necessary for the animal use protocol's final approval.

12.2 Hazardous Waste

To prevent exposing humans or harming the environment, radioactive animal wastes must be handled carefully. The RSC and EH&S have established guidelines for handling hazardous waste material. Any related costs will be met by the lead researcher upon estimate receive from waste disposal vendor.
The Principal Investigator is accountable for:

a. Adhering to all guidelines set forth by the IACUC.

b. Informing the animal care facility that radioisotope-containing animals will be kept there.

c. Informing the RSO that radioisotope-containing animals will be kept in the animal care facility and giving them any additional information, they may need.

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d. Before bringing cages back to the animal control facility for cleaning, make sure they have been decontaminated.

e. The carcass and bedding should be disposed of in accordance with the radioactive waste program.

12.3 Hazardous animal waste handling procedures

a) All work must be done in the spaces designated by the RSO. A Caution Radioactive Material label with the radioactive symbol is required to be displayed in these rooms.

b) After an animal has been given a radioactive substance, its cage and apparatus must be marked with caution tape that features the radioactive symbol (Figure 1.3a). The cage must also include the name of the researcher, the isotope used, the amount of radioactive material injected (in microcuries), the date of injection, and the route of injection. Photocopy of the tag to be applied by the cage is shown in Appendix XVI. The protocols involving the use of radioactive materials in animals will be reviewed by the IACUC in consultation with the RSO.

c) Each experimental animal must be identified after being exposed to radioactive materials. It is necessary to record and treat the cage, bedding, waste, and, occasionally, the rack and the room as radioactive. This implies that equipment, waste, and animals should be handled and disposed of with great care.

d) The authorized user is responsible for arranging for the collection of all radioactive waste (bedding, excrement, etc.) in authorized plastic containers and for contamination testing. The waste is delivered to the RSO for disposal if it is contaminated. Dead radioactive animals must be packaged tightly and stored in a freezer that has been designated by the RSO, and tagged with a copy of the label shown in Appendix XVII. Animal carcass should not be thrown directly into the trash can.

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13. RADIOACTIVE WASTE DISPOSAL

13.1 General

Regular disposal methods should not be used to discard radioactive waste. For the proper disposal of radioactive waste, specific rules, regulations, and guidelines (25 TAC 289.202(ff)through (kk)) must be followed. Authorized users and their staff must aggressively segregate waste in order to comply with state and federal rules and regulations on radioactive waste disposal and provide cost-effective waste management. The emphasis is on segregating various waste types based on radionuclide, half-life, chemical form, physical form, or combinations of these. Following the use of radioactive material in laboratories, radioactive waste—which includes solid, bulk liquid, liquid scintillation vials, and animal carcasses—must be stored in designated containers and kept for collection by the RSO. All radioactive waste must be disposed of safely so as not to endanger the welfare of the general public, the health of HSC employees, or the value of a property. The RSO will carry out the final disposal of all radioactive wastes, with the exception of trace amounts through the sanitary sewer system.
HSC uses specifically authorized management practices to segregate waste, hold waste, and dispose of waste in order to dispose of radioactive material economically. These procedures will ensure that the institutional waste disposal budget is used as effectively as possible if they are followed by authorized users and their staff. Users will need to pay a fee to dispose of radioactive wastes if there are significant deviations from these standards (always contact RSO or Safety Office to avoid this).

It is the responsibility of authorized users and their staff to contact the RSO for radioactive waste pickup. Wastes must not be allowed to accumulate in a laboratory to the point where they pose a health risk. Workers can arrange for waste pickup by contacting the RSO at safety@unthsc.edu. All wastes transferred to the RSO must be properly packaged and labeled by authorized users. Authorized users should avoid producing waste that contains a mix of short and long-half-life materials unless double-label experiments are required. In general, solids and liquids waste must be segregated. Similarly, short half-life isotopes must be distinguished from long half-life isotopes. Figures 13.1 and 13.2 outline waste segregation plans for solid waste and liquids wastes, respectively.

13.2 Waste Type

Dry solid, bulk liquid, liquid scintillation vials (LSV), and animal carcasses are the four main waste streams at UNTHSC. Rarely, certain operations that have been predetermined may produce gaseous wastes.

13.3 Dry waste:

Wastes that are dry, solid, and contain radioactive materials can be hazardous or non-hazardous. Without the RSC's approval, dry solid radioactive waste with a hazardous component (mixed waste) cannot be produced. All dry solid waste, on the other hand, must be in a chemical form

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that is acceptable for disposal in the nearby landfill and is not hazardous (always notify RSO of any radioisotope in possession).

13.4 Liquid waste:

There are two types of liquid waste: (a) aqueous bulk liquids and (b) mixed waste (organic) bulk liquids.

(a) Aqueous liquids: Aqueous liquids are bulk liquids with a pH range of 5 to 9, with no biological, pathogenic, or infectious material, and no hazardous properties. This category includes aqueous biodegradable scintillation cocktails. Organic non-biodegradable scintillation fluids, hazardous liquids, oils, other organic fluids, strong acids, and bases are NOT aqueous fluids and should never be mixed with them.

(b) Mixed (organic) bulk liquids: Mixed (organic) bulk liquids are radioactive bulk liquids that contain a hazardous component and exhibit hazardous material characteristics. If a bulk liquid contains hazardous chemicals such as toluene, xylene, or other flammable, toxic, or reactive fluids, it is considered mixed. NOTE: Regulations require the generator (sub-licensee) to be able to verify the contents of all wastes as well as their associated hazard classification.

13.5 Liquid scintillation vials:

Glass or plastic vials with a capacity of less than 50 ml each that contain—or have contained—liquid scintillation fluid are known as liquid scintillation vials. Opti-flour, Aqua-sol, Ready-Safe, and other biodegradable scintillation cocktails should be used unless there is no other option, in which case nonaqueous scintillation cocktails should be used. The LSV containers must NOT contain any blood or aqueous non-scintillation vials. Liquid scintillation counter standards, stock solution vials (NEN, ICN, etc.), and vials containing non-scintillation fluids are not permitted in LSV containers. NEVER combine biological or dry solid wastes in LSV containers.

13.6 Animal Carcasses:

This category includes any animal used in research that contained radioactive material. This would include all parts of these animals (for example, the body, internal organs, and so on).

13.7 Waste Segregation

Authorized users and their staff must aggressively segregate waste in order to comply with state and federal rules and regulations on radioactive waste disposal and provide cost-effective waste management. Figures 13.1 and 13.2 outline waste segregation plans for solid waste and liquids wastes, respectively. In general, solids and liquids waste must be segregated. Similarly, short half-life isotopes must be distinguished from long half-life isotopes. Authorized users should avoid producing waste that contains a mix of short and long-half-life materials unless double-

label experiments are required. The RSO is always available to assist authorized users and workers in determining the best way to separate waste.

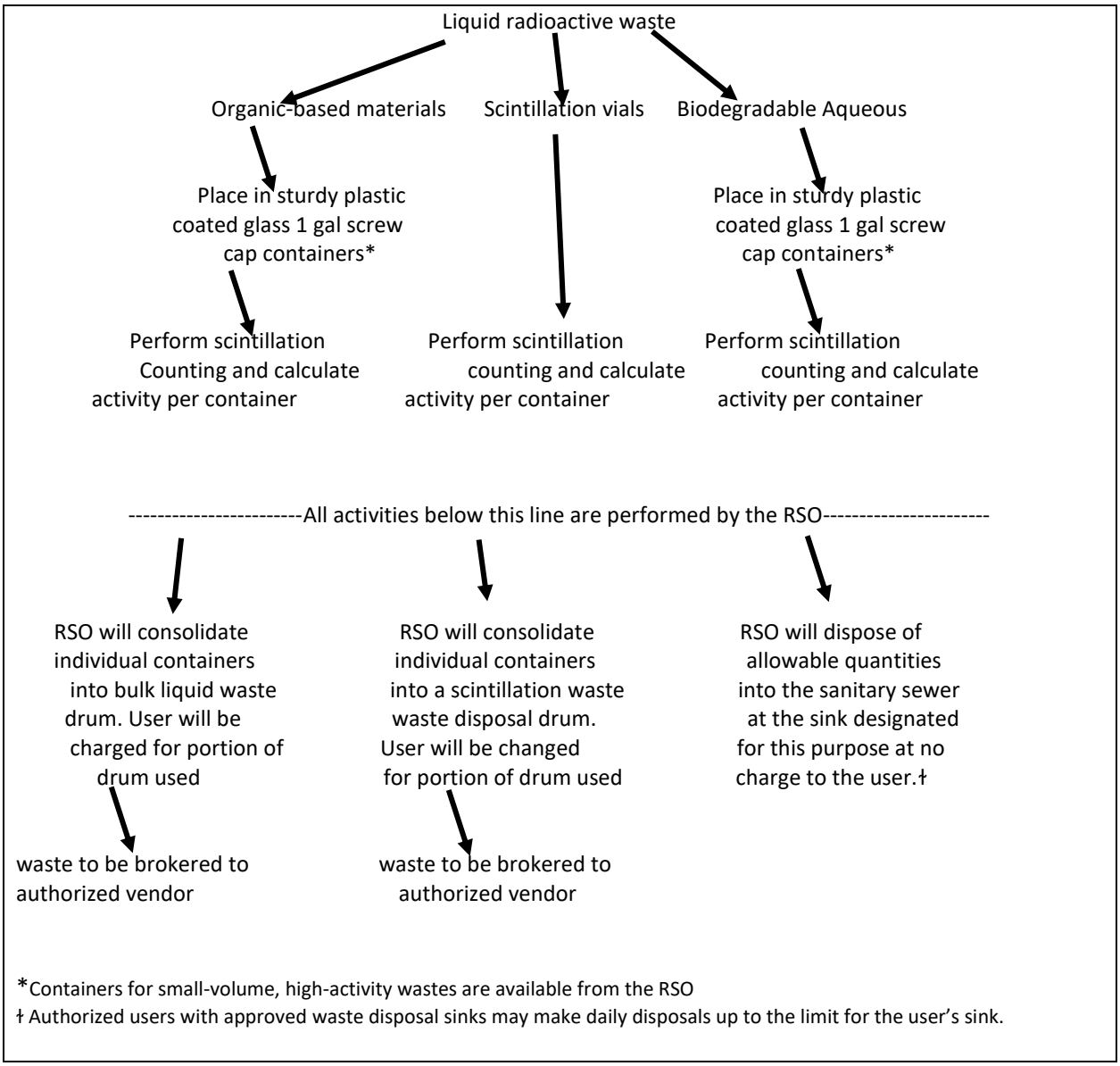

Figure 13.1: Segregation of liquid radioactive waste

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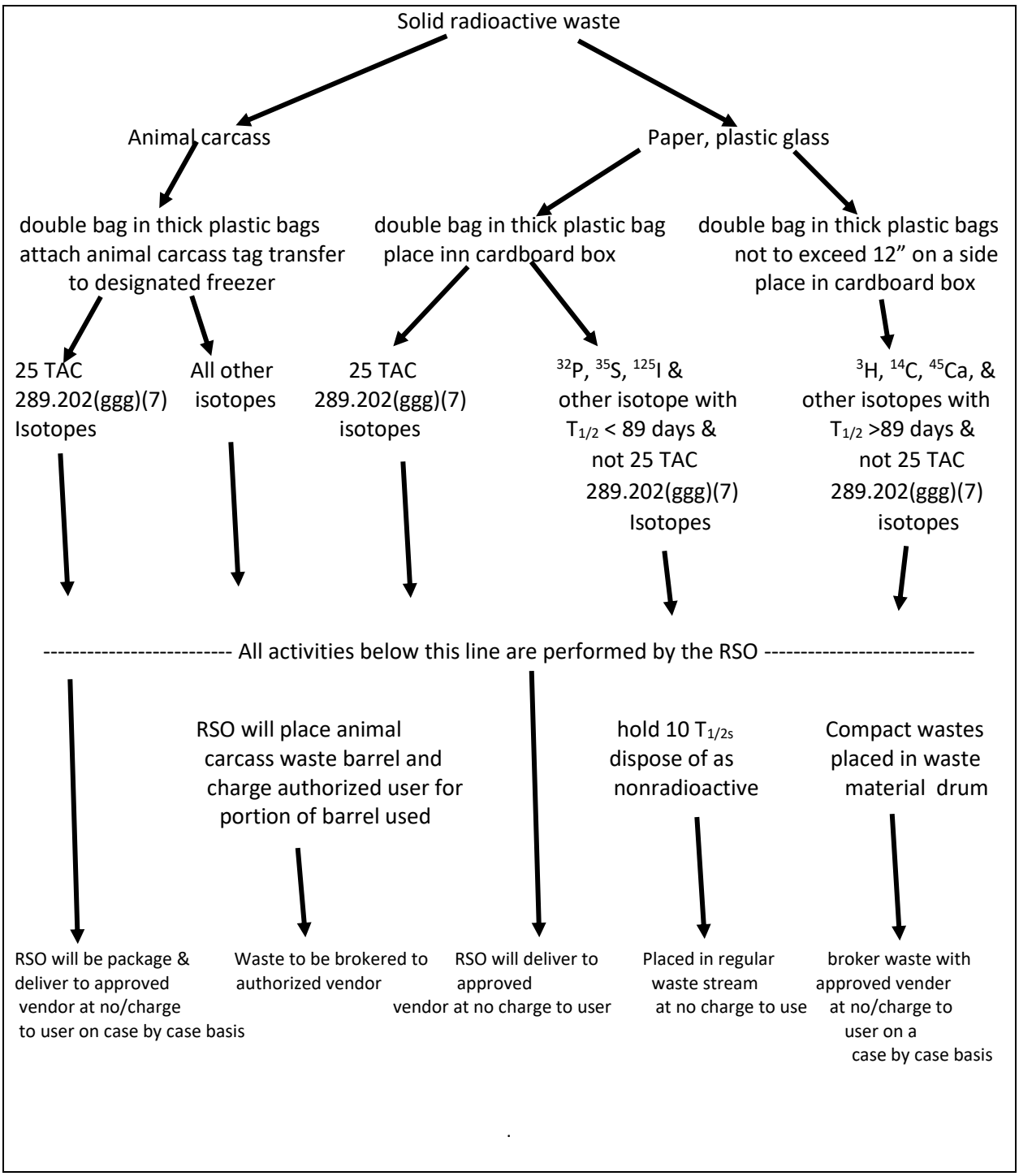

Figure 13.2: Segregation of solid radioactive waste

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13.8 Solid Waste Disposal

If empty scintillation vials meet the criteria for specific wastes as listed below in disposal of specific wastes, they may be disposed of in the regular trash. Empty vials that don't fit these criteria need to be double bagged in strong plastic bags before being delivered to the RSO along with other radioactively contaminated paper, glass, and plastic items.
Paper, plastic, and glass that are radioactively contaminated and do not fall under the definition of specific waste as stated in the disposal of specific wastes section must be double bagged in plastic, put in sturdy cardboard containers, and labeled as previously mentioned.

Isotopes with half-lives greater than 89 days that are not listed in Appendix XVIII of this manual must be stored in bags no larger than twelve inches on a side. At the time of transfer, users must identify isotopes and amounts to the RSO. Each waste cardboard container or bucket (Appendix XIX) will have a waste disposal sticker stick to it which is obtain from the RSO. Appendix XIX contains a copy of such a sticker. The sticker is a duplicate (white and yellow) which the RSO take the white and the lab retain the yellow for records.
The RSO compacts such materials before placing them in waste drums. These wastes will be transferred to a radioactive waste broker who has been approved by the Bureau of Radiation Control to conduct such business.

Paper, glass, and plastic waste contaminated with isotopes with half-lives of less than 89 days must be double bagged and placed in a cardboard container. The package is then handed over to the RSO. At the time of transfer, users must identify isotopes and amounts to the RSO. A waste disposal sticker (Appendix XIX) must be stick on each cardboard container. These wastes will be stored for ten half-lives.

The RSO and his staff will then open the packages, conduct a survey of the exterior of the package with a thin window Geiger counter, and record the results. All identifying tape, marks, and so on must be removed from the contents, and the contents of the package disposed of as non-radioactive wastes in regular garbage. If a package is discovered to contain isotopes other than those identified by the RSO, ordering of isotopes will be temporarily halted for the authorized user whose package was mislabeled. This moratorium on ordering will be in effect until the RSO and RSC are satisfied that steps have been taken to prevent a repeat of the incident.

Laboratory personnel must discard paper, glass, and plastic wastes that meet the definition of specific wastes as described in the disposal of specific wastes.

If laboratory personnel have any doubts about whether items meet the specific waste definition, they must consult with the RSO.

13.9 Liquid Waste Disposal

Laboratory personnel must label liquid waste containers as described above. Workers can request pickup via link on Radiation Safety webpage. Workers must have the scintillation counting

results from each waste container available for inspection by the RSO.
The RSO will verify that proper counting channels were established and that wastes were correctly identified and quantified. Waste from authorized users will not be accepted unless these requirements are met.

13.9.1 Biodegradable liquids

Biodegradable liquid wastes containing radioisotopes in solution may be transferred as bulk liquid wastes to the RSO. These wastes, which should include biodegradable scintillation fluid, should be stored in one-gallon plastic or plastic-coated glass bottles.
The RSO must dispose of these bulk liquids by either dumping them into the sanitary sewer or storing short-lived isotopes for decay and then disposing of them as non-radioactive wastes or as specific wastes as described in the disposal of specific wastes. If waste is held, the RSO must attach a sticker identifying the waste, the date of transfer, and who generated the waste.
Appendix XIX contains a photocopy of such a sticker.

Authorized users with an approved waste disposal sink may dispose of certain isotopes in the quantities specified by the RSO, as described in this manual's section on sanitary sewer use. **Without the prior approval of the RSC, no authorized user may dispose of radioactive material into the sanitary sewer.**

13.9.2 Organic-based or contaminated liquids

Organic-based scintillation cocktails and aqueous solutions containing chlorinated organic solvents, solvents that are not miscible in water, or other environmental toxins must be separated from other biodegradable liquid wastes by authorized users and their staff.
Workers must use appropriate scintillation counting techniques to determine the isotopes and quantities of radioactive materials. These materials must be labeled and packaged in solvent-resistant containers, as described above. The authorized user is responsible for contacting the RSO for pickup.
For such wastes, the RSO must keep a bulk liquid-type disposal barrel on hand. These wastes will be transferred to a radioactive waste broker who has been approved by the Bureau of Radiation Control to conduct such business.

13.9.3 Scintillation vials containing solvents

Scintillation vials containing radioactive materials and solvents of any kind can be transferred to the RSO at the expense of the user. Such wastes will be held in barrels for this type of waste before being brokered by the health science center to a waste vendor approved by the Bureau of Radiation Control for such business.

13.9.4 Use of the sanitary sewer

Radioactive material may not be discharged into the sanitary sewer system of the health science center unless it is readily soluble or dispersible in water and can be released only after approval of the RSO in consultation with the RSC. Short-lived radioisotopes may need to be held for decay before disposal into the sanitary sewer system. Limits for each radioisotope are specified in 25 TAC 289.202(ggg)(2)(F) Table III for use with 25 TAC 289.202(gg) (1) (link). The gross

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quantity of radioisotopes released into the sanitary at the UNTHSC must not exceed one curie per year. Mixtures of radioisotope with environmental toxins can prevent the disposal of isotopes through this avenue. Therefore, users shall avoid contamination of radioactive wastes with environmental toxins which restrict the waste disposal. No alpha isotopes may be discharged into the sewer system.

13.9.5 Disposal of liquid radioactive wastes via the sanitary sewer system:

1) The disposal of small quantities of water-soluble liquid radioactive wastes is allowed under state and federal regulations.

2) The disposal of any isotopic material in the sanitary sewer requires prior approval of the Radiation Safety Officer. Individuals making disposals shall demonstrate proficiency in scintillation counting prior to performing disposals.

3) Unless otherwise approved, this disposal will only be permitted in the stainless-steel sink in the Chemical Bunker at 1050 Clifton Street.

a) Authorized users may apply to the RSO and RSC for permission to designate a sink for disposal. Users will provide a rationale for their request.

b) Authorized users with a radioactive disposal sink in their laboratories will make the disposal site available, on a reasonable basis, to other authorized users during normal working hours.

c) The authorized user will assume the responsibility of keeping disposal records for that sink. The following information shall be recorded for every disposal on a daily log posted adjacent to the sink (see Appendix XXI):

i. The date of the disposal
ii. The identity of the isotope
iii. The number of µCi disposed
iv. The name of the authorized user whose isotope (s) are disposed.

d) A space will be provided on the daily log sheet to indicate the total radioactivity disposed in the month and the quantities disposed for the month broken down by isotope.

e) The Authorized user will forward a copy of the disposals made to the RSO at the end of each month.

f) Sink disposal records will be reviewed at the quarterly RSC meeting.

g) Before a sink is designated as a disposal point, a plumber will inspect the sink and certify that it is sealed properly, and that the plumbing under the sink is in good repair.

h) The sink shall be fitted with a drip pan to hold at least 1 gal of liquid. The RSO shall be immediately notified if a leak is discovered.

i) The sink shall be prominently posted as a radiation disposal point [Figure 1.3a) and the allowed limits for specific isotopes will be posted in µCi/day.

j) If a user wishes to vacate a laboratory with an approved disposal sink or desires to convert the sink back to general use, the user will inform the RSO well in advance of the anticipated change, the user will perform wipe tests on the sink and sample the plumbing of the sink at the U-joint for radioactive contamination.

Sinks and U-joints shall have less than 0.005 µCi of removable radioactivity / 100 sq. cm. prior to being designated as general-use sinks. Following a review of wipe test data by the RSO and approval, the sink may be designated as a general use area.

4) The RSO will keep a permanent record of all radioisotopes disposed into the sanitary sewer system.

5) The RSO will perform calculations when there is a change in the number of sinks or number of isotopes disposed to ensure that the sum of fractions is never exceeded, that the total 1 Ci / yr. limit is never exceeded, and that the daily disposal limits for each sink are updated. Disposal needs will be reviewed at quarterly RSC meetings and new disposal limits issued as appropriate.

13.10 Carcasses and Waste from Animals

Radioactively contaminated dead animals must be prepared and kept frozen. Until the RSO can make arrangements for animal disposal through a contracted radioactive waste broker, the PI is in charge of keeping the animals in storage (frozen). The freezer's labels will be provided by the RSO.

13.11 Radioactive waste labeling

All waste containers for radioactive materials must have a sticker or tape affixed to the outside of the container with the international radiation symbol and the words: Caution Radioactive Material.

The container must be labeled to identify the isotope(s) and the total activity of each isotope in Ci or mCi. The RSO provides a special tag for animal carcasses for this purpose.

13.12 Disposal of Specific wastes

For the purposes of this manual, specific wastes are defined as wastes containing concentrations of tritium, carbon-14 and/or iodine-125 within limits specified by 25 TAC 289.202(fff) (1). Specifically:

1) 0.05 microcuries or less of tritium, carbon-14 and iodine-125, per gram of medium, used for liquid scintillation counting or in vitro clinical or in vitro laboratory testing;

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2) 0.05 microcuries or less of tritium, carbon-14 and iodine-125, per gram of animal tissue averaged over the weight of the entire animal; provided however, tissue is not disposed of in a manner that would permit its use either as food for humans or as animal feed.

Laboratory personnel may dispose of waste which meets these criteria without regard to its radioactivity: Animal carcasses which meet the test of this section may be disposed of by delivering to approved licensed vendor to be buried as special wastes in a type I sanitary landfill by either the Director of Laboratory and Animal Medicine and his staff or RSO.

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14. GENERAL RADIATION SAFETY GUIDES

14.1 General Radiation Safety Guides for Radioactive Material Use

a) For all laboratory personnel, the procedure for each project/research should be clearly outlined in writing. Equipment, waste containers, and survey instruments must be readily available.
b) The radioactive material's properties, such as type of radiation, energy, half-life, significant and typical amounts, and chemical form, should be known.
c) In some cases, a "dry run" practice of the procedure may be useful to avoid problems before the procedure is actually performed with radioactive material.
d) In a radioactive material laboratory, a radiation employee should supervise visitors and students.
e) In controlled areas, personnel monitoring badges must be worn.
f) Radioactive waste must be disposed of only in the designated containers. Non-standard containers are not permitted.
g) Stock shipments must be handled and stored in specific locations.
h) Radioactive material should not be left unattended in areas where it could be handled or removed by unknowing or unauthorized individuals. When not in use, all lab rooms and waste storage areas must be locked.
i) In general, work with radioactive materials should be limited to only the areas required. This simplifies the problem of confinement and shielding and helps to limit the affected area in the event of an accident.
j) Cover all work surfaces and storage areas (tabletops, hoods, floors, and so on). Some older buildings are extremely difficult to decontaminate.
k) Absorbent mats or paper are recommended. It is especially useful to have a protective absorbent with a plastic back and an absorbent front. If contaminated, simply dispose of it in the radioactive waste container.
l) Spillage should be avoided, but in the event of an accident, adhere to the established emergency procedures.
m) Conduct radiation meter and wipe test surveys on a regular basis. When measurements are abnormal, determine the cause and make the necessary corrections.
n) When using liquids, plastic or metal trays (stainless steel is easy to clean) should be placed on the surface. The tray serves to contain a spill and must be large enough to hold the total volume in use.
o) Good housekeeping is required at all times. The likelihood of accidental contamination or unnecessary exposure is reduced when an area is kept neat, clean, and free of equipment that is not required for the immediate procedure.
p) When possible, radioactive materials, particularly liquids, should be stored in unbreakable containers. A secondary container must be provided if glass is used.
q) DO NOT PIPETTE BY MOUTH! Use a mechanical pipette-filling device at all times.
r) It is forbidden to eat, drink, smoke, apply cosmetics, or store food where radioactive material/waste are used and/or stored.
s) Refrigerators used to store radioactive material are not permitted to be used for food storage. Radiation warning stickers must be prominently displayed in all storage compartments (refrigerator and freezer sections).

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t) Smoking is prohibited in radioactive zones.

u) Thoroughly wash your hands after working with or near radioactive materials, as well as before eating, drinking, smoking, or applying cosmetics.
v) When using an unsealed radiation source, protective gloves must be worn. Do not use (potentially) contaminated gloves to answer the phone, handle books, or open cabinets. Wear gloves if there is a break in the skin on your hand.
w) All individuals handling radioactive material must wear lab coats and appropriate shoes as well as other PPE as required by approved protocol.
x) After using radioactive material, all reusable glassware and tools should be thoroughly cleaned and stored separately from non-contaminated items. It is recommended that glassware and tools used in radioactive work be stored in a clearly marked container or area.

14.2 Eating, Drinking and Smoking Policy

Contamination of food, drink, tobacco products, and cosmetics is a potential route for hazardous substance ingestion. Food must be stored, handled, and consumed in a safe environment free of hazardous substances. Food storage and eating areas for laboratory personnel are to be designated in non-laboratory areas such as nearby break rooms, lounges, or conference rooms. According to the HSC Chemical Safety Manual, no eating, drinking, smoking, chewing gum or tobacco, applying cosmetics, or storing utensils, food, or food containers in laboratory areas where chemicals, carcinogens, and toxins are used or stored are permitted.

14.3 General Radiation Safety Guides for Radiation Producing Machine

a) Anyone who intends to operate a radiation-producing machine must be trained in its use by someone who is familiar with the system.
b) Each person who works with a radiation machine should understand exactly what work is to be done and which safety precautions should be taken.
c) Before operating radiation machines, personnel must have access to written operating and safety procedures.
d) The equipment operator should supervise visitors and students in the work area.
e) Radiation-producing machines should not be left unattended while in operation.
f) RSC must approve structural shielding requirements for any new installation, as well as any modifications to an existing unit or room, before the machine is put into service.
g) When the safe operation of the equipment is dependent on the mechanical configuration of the unit or on technique factors, these restrictions must be strictly adhered to.
h) No shutter mechanisms or interlocks shall be defeated or altered in any way except in accordance with approved written procedures.
i) All warning lights should be "fail safe" (fail safe features are required by specific regulations).
j) To indicate elapsed time and to turn off the machine when total exposure reaches the planned amount, a manually reset cumulative timing device should be used.
k) Working with x-ray units requires extra caution. And as such individuals using these devices must have specific training, operation, and emergency response procedures.

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l) Certain machines, such as analytical x-ray machines, irradiators, and accelerators, have their own safety programs. Operating and emergency procedures must be posted and followed in detail.

(m) All radiation-producing equipment must be properly maintained. Only properly trained technical personnel should repair these instruments. The state of Texas requires service personnel to be licensed or registered.

Appendices XXII – XXIX contain some useful information such as Progressive Discipline for Monthly Area Surveys, Revised Version, Prohibited use of ^{3}H, Prohibited uses of Radioiodine ^{125}I and ^{131}I, Radioisotope usage history for unused isotope that is stored for more than 2 years, Conditions for Dosimetry, Safety Data for Commonly Used Radionuclides, and Radiation Emergency Response Guidelines.

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15. EMERGENCY PROCEDURE

The use, storage, or transfer of radioactive material can result in an emergency situation or accident, as can improper use or abuse of machinery that emits X-rays or other types of ionizing radiation.

The goal is to improve each Authorized User's and worker's capacity to respond appropriately to radiation accidents.

It would be impractical to list every procedure that needs to be followed for every kind of accident at HSC because of the wide range of potential mishaps. Instead, one should follow the fundamental steps below and adapt them to his or her particular situation. Preparing for radiation accidents is the best advice for defense against them.

15.1 General information

The definition of a radiation incident includes any unintentional incident, any single exposure or suspected exposure that exceeds 45% of the maximum allowable exposure, the ingestion of radioactive material in excess of limits in the form of liquid, gas, or dust, and any radioactive material spill regardless of activity or size.
If people involved in a radiation incident are unsure about the extent of their exposure, ingestion, or the magnitude of the spill, they must proceed under the assumption that an overexposure (internally or externally) or major spill has occurred, unless otherwise noted. All radiation incidents must be reported to the RSO by users.

The RSO shall have the responsibility of conducting incident investigations. The authorized user involved will be invited to the following RSC meeting to answer questions and give a report on the incident if preliminary findings of an incident reported to the RSC indicate there is probable cause of neglect or violation of state, federal, or local laws or institutional policies.

15.2 Organization and Authority

The RSO will have the power to stabilize the situation in the event of a serious emergency. However, this RSO authority will only be applied in the most dire circumstances, such as when there is a serious building contamination or an immediate radiological threat to a person or people.
Each radiation-authorized user or worker must know how to:

a) Recognize a radiation emergency, according to the RSO.

b) Prevent or limit the accident.

c) Keep every member of the staff away from any potential exposure.

d) Request assistance right away from his or her supervisor, the RSO, and/or other emergency personnel.

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Each authorized user is accountable for ensuring that the employees under their supervision have workable emergency plans that anyone can understand, as well as for managing emergencies in their specific laboratories.

15.3 Radioactive Spill Policies

Minor Spills (< 100 microcurie level)

a. Notify other laboratory personnel and reduce radioactive material ingestion, inhalation, and so on.

b. Prevent the spread of accident contamination.

c. Notify the RSO.

d. Survey all individuals involved, decontaminate if necessary, and release unneeded individuals.

e. Start the decontamination procedures.

f. Report the incident to the RSO.

Major Spills (> 100 microcuries or any amount of activity that results in personnel contamination)

a. Alert everyone in the lab and try to avoid ingesting or inhaling radioactive material. Leave the space.

b. Stop the accident's contamination from spreading.

c. If at all possible, shield the source, but only if doing so won't result in additional contamination or significantly increase your radiation exposure.

d. Notify the RSO.

e. To prevent the development of airborne contamination, if at all possible, block all air vents.

f. Shut the door.

g. Inspect everyone involved and, if necessary, decontaminate. Persons directly involved should not be released unless they need immediate medical attention. Await the RSO's or RSC's release authorization.

15.4 Personal Injuries

When a person has a break in the skin (cut, scrape, etc.) below the wrist, they should not work with uncontained radioactive material. If a person is cut by a radioactively contaminated article, the following guidelines should be followed:

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1. Cleanse the wound as soon as possible by submerging it in running water. Keep any cotton swabs, paper towels, fluids, etc. if you can so they can be used for radiological analysis. Notify the RSO as soon as you can.

2. If necessary, take the person/patient(s) to an emergency care. Make sure to inform the medical staff that the accident involved radioactive material.

3. Subsequent to the RSO's guidance, carry out the necessary actions listed in the below section (Possible Radiation Overexposure Accidents).

Before using more drastic decontamination techniques, speak with the RSO.

15.5 Accidents Involving Serious Radioactive Material Releases

a. Notify everyone in the area about the accident.
b. If you can, hold your breath and shut all air vents.

c. If you can, leave the space and secure it.

d. Immediately inform the RSO.

e. Secure access to the area.

f. Keep an eye out for contamination among everyone involved.

g. Help with and/or submit to any bioassay deemed necessary by the RSO or the DSHS.

h. Help the RSO with risk assessments and decontamination procedures.

15.6 Possible Radiation Overexposure Accidents

If radiation overexposure has occurred or is suspected, follow these steps:
a. Remove the affected person(s) from the area immediately and notify the RSO.

b. Make the area secure.

c. Immediately transport the affected person(s) to the nearest emergency center for clinical observation. Make sure the attending medical personnel are aware of the radiation accident. Prepare to answer any questions about the accident or the type of radiation involved.

d. Assist the RSO in gathering all incident details.

e. The RSO will obtain dosimetry readings from all individuals involved. The dosimetry readings will then be forwarded to the RSO for emergency processing.

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f. Individuals involved in the incident will be prohibited from working with radiological materials until exposure results are received and the RSO determines that exposure limits were not exceeded.

g. The RSO will submit reports to the RSC and other regulatory bodies.

15.7 Radiation Equipment Loss or Theft

The RSO must be notified right away in the event that radioactive material, a device containing radioactive material, or a device producing radiation is lost or stolen. The RSO will assess the damage's scope and consider the best course of action.
The RSO will notify the RSC and the State regulatory Agency as necessary.

15.8 Radiation Producing Equipment Malfunction

Any radiation device (X-ray, etc.) that is suspected to be broken must be locked into place and made inoperable right away. Individual users, authorized users, and/or the RSO may act in an emergency to protect the source, turn off the equipment, or retrieve the source.
Prior to the arrival of the RSO, the responsible user must limit access to the area. The RSO will thoroughly investigate the incident, inform the RSC in writing within ten days, and, if necessary, report the incident to the DSHS within thirty days.

Rebuilding or repairing any source of encapsulated radioactive material is NOT ALLOWED. Radiation sources that have been a part of an incident—such as a fire, flood, or accident—may not be used until they have been examined by the RSO and deemed to be in a suitable and secure operating condition.

15.9 Major Emergency; Fire or Explosive

a. Issue an immediate call to evacuation for everyone nearby.
b. Inform the RSO, the HSC Police Department, Fort Worth Fire Department, EMS, and other supervisory staff. Give them the location of the fire and the address.

c. If firefighters arrive ahead of the RSO, let them know that there is radioactive material nearby. Be prepared to provide them with any other information necessary to prevent radioactive contamination of personnel, a building, or equipment, including the location, isotope(s), activity(s), type of storage, etc.

d. The authorized user and/or workers will need to be on hand in order to assess the level of damage to radioactive material and/or check for radioactive material contamination on emergency personnel and equipment.

e. An incident report must be submitted to the RSO by all involved authorized users and employees.

f. An authorized user or worker may attempt to douse a MINOR FIRE with approved fire-fighting equipment if the fire is minor (individual decision), and there are no radiation or chemical hazards involved.

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15.10 Radiation incident reporting

Each authorized user has a duty to support the RSO in managing and/or investigating the accident. In addition, the authorized user is accountable for helping the victim(s) get medical attention as soon as it is possible, if necessary.

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16. RECORDS

EHS is responsible for maintaining portal-to-portal surveillance of all radiation sources on campus in accordance with the conditions of the University's licenses to use radiation sources. It is necessary to keep specific records and reference materials in order to facilitate this surveillance and ensure that a high awareness of the laws and rules governing the safe use of radiation sources is maintained. Unless otherwise instructed, records must be kept for three years by the Authorized User and EHS.

Among these documents and sources are, but not restricted to, the following:

a. A current radiation safety manual for the university. All previous iterations must be archived.
b. Copies of the RSO forms that were sent to EH&S
c. Forms for the Monthly Inventory Record of Radioactive Materials.
d. EHS and the Authorized User radiation and contamination surveys
e. Records of the disposal of radioactive waste.

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SECTION III

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APPENDIX I

NOTICE TO EMPLOYEES

Figure: 25 TAC §289.203(i)
RC FORM 203-1

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.

APPENDIX II

STATEMENT OF TRAINING AND EXPERIENCE

Documentation for non-RAM Users

Print Name: _____Authorized User: _____

Radioactive Material: _____ Department: _____

University Phone: _____ University Email: _____

Check One: ☐ FACULTY ☐ STAFF ☐ STUDENT

I plan to use (check all that apply):
☐ unsealed sources of radionuclides (which ones? _____)
☐ X-ray generator ☐ sealed sources only

A. Have you ever received **formal training** in the following topics? Check YES or NO below. [Radiation Safety Courses at other institutions and lectures on the topics as part of college-level coursework (for example- Physics, Biology, Chemistry, etc.) would be considered formal training.]

Principles and Practices of Radiation Protection	☐YES	☐ NO
Basic nuclear interactions	☐ YES	☐ NO
Biological effects of radiation	☐ YES	☐ NO
Exposure control basic principles	☐ YES	☐ NO
Calculations basic to the use and measurement of radioactivity	☐ YES	☐ NO
Radioactivity monitoring techniques and instruments	☐ YES	☐ NO

If you checked YES for any of the above, complete the section below.

Name of the course/lecture	Location where training was received

B. If you ever handled radioactive materials before and thereby received **on-the-job training** in the above
topics, complete the table below—

Radionuclide Used	Maximum experimental activity used	Location where radionuclide was used	Length of time radionuclide was used (# of years)	Experimental procedure(s) performed with radionuclide

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C. Have radiation exposure records been maintained for you at another institution?

Check One: ☐ YES ☐ NO

If YES, indicate the name of institution(s)

_____

☐ I have read and will abide by the University policies set forth in the HSC Radiation Safety Manual.

Signature: _____ Today's Date: _____

_____

If additional space is required, attach additional sheets.

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APPENDIX III

APPLICATION FOR POSSESSION AND USE OF RADIOACTIVE MATERIAL AND EQUIPMENT

PLEASE CLEARLY PRINT/ FILL OUT COMPLETELY AND KEEP A COPY FOR YOUR RECORDS

Title:		
NAME (LAST, FIRST)	POSITION/ TITLE	DATE
DEPARTMENT MAILING ADDRESS	OFFICE & EMERGENCY PHONE #	EMAIL

BUILDING AND ROOM(S) WHERE RADIOACTIVE WORK WILL BE PERFORMED	PREVIOUSLY AUTHORIZED BY RADIATION SAFETY COMMITTEE AS: Authorized User ☐ For ___ Years General User ☐

Do you plan to use radioactive material in animals?
☐ Yes ☐ No
Will work involve use of >100 m Ci of a radionuclide with greater than 120 days half-life? ☐ Yes ☐ No
Will you be working with any biological hazard?
☐ Yes ☐ No
(If yes to any of the above, attach additional documentation and IACUC authorization)

PERSONNEL MONITORING AND PROTECTION
Please refer to the Radiation Dosimetry Guideline at the end of this application to determine the requirements for dosimetry.
☐ I currently have a whole-body badge
☐ I currently have a ring badge
☐ I am currently using only ^{3}H, ^{18}F, ^{64}Cu, ^{14}C, ^{33}P, & ^{35}S.
☐ I will not require a badge (I will be using less than quantities shown in RSP Dosimetry Guideline.
☐ I will apply for a badge from EHS via RSO

SECURITY PLAN
Principal Investigators must submit security plan for all areas where radioactive materials or equipment will be used or stored and a protocol. Must be attached with this application.

LABORATORY/ FACILITIES DESCRIPTION
Please attach a **blueprint/ map** of each room which includes the locations of fume hoods, work stations, waste areas & containers, radiological equipment, entrance and exits, etc.

Instrumentation to be used for radiation monitoring

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Type, manufacturer, model and description, serial # and Institutional Tag # (if applicable)

A. _____

_____

B. _____

_____

LABORATORY MONITORING/ SURVEY

☐ Any laboratory under my authorization/ supervision will be surveyed at least once every calendar week if radioactive material will be used.

Proposed use of each radionuclide/ equipment

MACHINE/ NUCLIDE	REQUESTED LIMIT	Name of Institution PROCEDURE will be performed	MAX. ACTIVITY PER PROCEDURE (µCI)	ESTIMATED # OF PROCEDURES PER MONTH/ WEEK/ HOURS

Procedure(s)

Brief description of the procedure(s)

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Bioassay

COMPLETE THIS SECTION IF IODINATIONS WILL BE PERFORMED UNDER THIS AUTHORIZATION OR IF ANY CONTAINER OF RADIOIODINATED COMPOUNDS POSSESSED UNDER THIS AUTHORIZATION WILL CONTAIN FIVE (5) MILLICURIES OR MORE OF IODINE-125.

MAX. Activity per container (mCi)	Physical Form	Chemical Form	Location

- Use of a central iodination laboratory? Yes ☐ No ☐
- Attach a copy of iodination procedure that will be followed including an estimate of the typical tagging efficiency that is expected.

Attach a list of every individual who will be performing iodination or who will be handling any container with one (1) millicurie or more of any radioiodinated substance.

Training (Authorized User(s))

Name: Last, First	Degree	Radiation Safety Training	INSTITUTION(S)	DATE From	To
		Yes ☐ No ☐			
		Yes ☐ No ☐			
		Yes ☐ No ☐			
		Yes ☐ No ☐			

Isotope Usage Experience

NUCLIDES USED	QUANTITY (μCI)	INSTITUTION	DATE	USE TYPE

Signature

UNT HEALTH SCIENCE CENTER RADIATION SAFETY MANUAL CONTAINS THE POLICIES AND RULES GOVERNING THE USE OF RADIATION-PRODUCING MATERIAL AND EQUIPMENT AT HSC AS SPECIFIED BY THE RADIATION SAFETY COMMITTEE AND MUST BE ABIDED BY ALL USERS.

I HAVE READ AND WILL ABIDE BY THE UNIVERSITY'S PROGRAM REQUIREMENTS AND POLICIES AS SPECIFIC IN THE RADIATION SAFETY MANUAL.

I attest that all information provided on this application is true and accurate:

FULL NAME OF APPLICANT: _____

SIGNATURE: _____ DATE: _____

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Approval

We verify that the application received is complete based on the information received

Radiation Safety Officer: _____ Date: _____

Radiation Safety Committee (Chair): _____ Date: _____

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APPENDIX IV

SAMPLE PROTOCOL OF RESEARCH INVOLVING THE USE OF RADIOISOTOPES

Complete one of these forms for each radioisotope to be used in live animals. Form(s) must be signed by the licensed principal investigator responsible for radioisotope use in animals.

An approved protocol by the institutional radiation committee is required to work with radioisotopes

Send completed, signed forms to George.Osei@unthsc.edu or deliver to the Environmental Health and Safety Office, GSB 110. 1.

1. Project Title _____

2. PI Information

Name: _____ Office Phone: _____

Dept./College: _____ Lab Phone: _____

Email: _____

3. Project summary: (Please provide a summary of the project and your plan to use radioisotope in the proposed project)

4. List all Authorized Users:

5. Radioisotope to be used in the project: _____ Chemical from: _____

Quantity (µCi): _____ Manufacturer: _____

6. Will this research involve the use of animals? Yes ☐ No ☐

If No, proceed to section 11.

7. Do you anticipate the use of any biohazard material in this project? Yes ☐ No ☐

If yes, list the biohazard agent: _____ Approved IBC protocol #: _____

8. Animal protocol title: _____

8. i. Animals to be dosed with radioisotope: _____

8. ii. Animals species: _____

8. iii. Total number of animals to be dosed: _____

9. Radioisotope Administration

9.i. Amount of activity administered to each animal: _____µCi

9. ii. Route of Administration: _____

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9. iii. Will animal be anesthetized immediately after administration? Yes ☐ No ☐

9. iii.a. If Yes, length of time animal will be kept under anesthesia (before experiment): _____

9. iv. Will animal be sacrificed/euthanized after experiment? Yes ☐ No ☐

9. iv.a. Briefly explain plan for Yes or No above:

10. Location (s) where an animal is dosed and maintained *:

*Animals can only be maintained in a laboratory for < 24 hours. If > 24 hours of housing in a laboratory is necessary, IACUC approval must be obtained prior to housing the animal in the laboratory.

11. Describe the procedure using radioisotope:

12. Please provide justification for the use of radioisotope in animal study.

13. Describe the radioisotope waste collection and disposal process

14. Describe the spill cleanup process:

15. Describe the emergency exposure process:

16. Describe the transportation process:

17. Outline a pilot project plan to validate the safety of the process.

18. Investigator's Statement:

☐ The information I have supplied above is a complete and accurate description of my use of this radioisotope in this species. I certify that I will comply with all of the institutional policies and Texas State Health Department regulations regarding the proper use of radioisotopes, maintenance of required records, and waste disposal. All individuals listed above as authorized users have received training in radiation safety practices within the past year.

_____ _____

PI's Signature Date

19. Approvals:

Radiation Safety Committee comments:

_____ _____

Radiation Safety Officer Date

_____ _____

Radiation Safety Committee (Chair) Date

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APPENDIX V

RADIONUCLIDE TOXICITY CLASSIFICATION

Very High Radiotoxicity (Group 1)

Pb-210	Ra-228	Th-229	U-232	Pu-236	Pu-241	Am-243	Cm-244	Cm-248	Cf-251
Po-210	Ac-227	Th-230	U-233	Pu-238	Pu-242	Cm-240	Cm-245	Cf-248	Cf-252
Ra-223	Th-227	Pa-231	U-234	Pu-239	Am-241	Cm-242	Cm-246	Cf-249	Cf-254
Ra-225	Th-228	U-230	Np-237	Pu-240	Am-242m	Cm-243	Cm-247	Cf-250	Es-254
Ra-226									

High Radiotoxicity (Group 2)

Na-22	Y-91	Cd-115m	I-125	Ba-140	Tm-170	Pb-212	Ac-228	Pu-244	Cf-253
Cl-36	Zr-93	In-114m	I-126	Ce-144	Hf-181	Bi-207	Th-232	Am-242	Es-253
Ca-45	Nb-94	Sb-124	I-129	Eu-152	Ta-182	Bi-210	Th Nat	Cm-241	Es-254m
Sc-46	Ru-106	Sb-125	I-131	Eu-154	Ir-192	At-211	Pa-230	Bk-249	Fm-255
Co-60	Ag-110m	I-124	Cs-134	Tb-160	Tl-204	Ra-224	U-236	Cf-246	Fm-256
Sr-90									

Moderate Radiotoxicity (Group 3)

Be-7	Fe-52	Se-75	Zr-95	Pd-109	Te-132	Ce-139	Er-169	Pt-197	Pa-233
F-18	Fe-55	Br-82	Zr-97	Ag-105	Te-133m	Ce-141	Er-171	Au-196	U-231
Na-24	Fe-59	Kr-74	Nb-90	Ag-111	Te-134	Ce-143	Tm-171	Au-198	U-237
Si-31	Co-55	Kr-77	Nb-93m	In-111	I-120	Pr-142	Yb-175	Au-199	U-240
P-32	Co-56	Kr-87	Nb-95	Cd-109	I-123	Pr-143	Lu-177	Hg-197	Np-240
P-33	Co-57	Kr-88	Nb-96	Cd-115	I-130	Nd-147	W-181	Hg-197m	Np-239
S-35	Co-58	Rb-86	Mo-90	In-115m	I-132m	Nd-149	W-185	Hg-203	Pu-234
Cl-38	Ni-63	Sr-83	Mo-93	Sn-113	I-133	Pm-147	W-187	Tl-200	Pu-237
Ar-41	Ni-65	Sr-85	Mo-99	Sn-125	I-135	Pm-149	Re-183	Tl-201	Pu-245

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K-42	Cu-65	Sr-89	Tc-96	Sb-122	Xe-135	Sm-151	Re-186	Tl-202	Am-238
K-43	Zn-65	Sr-91	Tc-97m	Te-121	Cs-132	Sm-153	Re-188	Pb-203	Am-240
Ca-47	Ga-67	Sr-92	Tc-97	Te-121m	Cs-136	Eu-152m	Os-185	Bi-206	Am-244m
Sc-47	Zn-69m	Y-90	Tc-99	Te-123m	Cs-137	Eu-155	Os-191	Bi-212	Am-244
Sc-48	Ga-72	Y-92	Ru-97	Te-125m	Ba-131	Gd-153	Os-193	Rn-220	Cm-238
V-48	As-73	Y-93	Ru-103	Te-127m	La-140	Gd-159	Ir-190	Rn-222	Bk-250
Cr-51	As-74	Zr-86	Ru-105	Te-129m	Ce-134	Dy-165	Ir-194	Th-226	Cf-244
Mn-52	As-76	Zr-88	Rh-105	Te-131	Ce-135	Dy-166	Pt-191	Th-231	Fm-254
Mn-54	As-77	Zr-89	Pd-103	Te-131m	Ce-137m	Ho-166	Pt-193	Th-234	

Low Radiotoxicity (Group 4)

H-3	Mn-53	Ge-71	Sr-81	Mo-93m	Te-127	Xe-133	Cs-135m	Po-207	Pu-243
C-11	Mn-56	Kr-76	Sr-85m	Mo-101	Te-129	Cs-125	Cs-138	Ra-227	Am-237
N-13	Co-58m	Kr-79	Sr-87m	Tc-96m	Te-133	Cs-127	Ce-137	U-235	Am-239
C-14	Co-60m	Kr-81	Y-91m	Tc-99m	I-120m	Cs-129	Os-191m	U-238	Am-245
O-15	Co-61	Kr-83m	Nb-88	Rh-103m	I-121	Cs-130	Pt-193m	U-239	Am-246m
Ar-37	Co-62m	Kr-85m	Nb-89	In-113m	I-128	Cs-131	Pt-197m	U NAT	Am-246
Mn-51	Ni-59	Kr-85	Nb-97	Te-116	I-134	Cs-134m	Po-203	U DEP	Cm-249
Mn-52m	Zn-69	Sr-80	Nb-98	Te-123	Xe-131m	Cs-135	Po-205	Pu-350	

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APPENDIX VI

PROTOCOL/PERMIT AMENDMENT FORM

If you want to add an isotope, increase a possession limit, or add a protocol to an existing radioactive material use permit, you must submit this form to the Radiation Safety Officer (RSO).

Authorized User: _____ Department:_____
_____

Phone: _____ Location: _____ Mail Code: _____

Contact Person: _____ Location: _____ Lab

List all locations where radioisotope(s) will be used or stored:

RADIOISOTOPES	MAXIMUM POSSESSION LIMIT*

* Maximum Possession Limit is the maximum quantity of the radioisotope you may have on hand at anytime; it is the sum quantity of the radioisotope in storage, in use, and in waste.

		% Waste distribution						
#	Protocol title	Solid	Liquid aqueous	Liquid flammable	Scintillation vials aqueous	solvent	Animal	Stock Vial
1								
2								
3								
4								

Describe how to handle, use, and dispose of the radioisotopes for each of the listed protocols **on a separate sheet of paper**. Include in this description the quantities and types of radioactive waste produced, the radiolabeled compounds used, any chemicals added, and any dilutions that were carried out. Please discuss the inactivation or neutralization of the applicable hazards and/or the management and control of potentially contaminated animal by-products (excretions,

bedding, etc.) or field use by-products (air release, run-off, etc.) if any special hazards (e.g., toxicity, carcinogenicity, volatility, etc.) apply to the protocol. Describe the safety measures, handling techniques, and tools that will be used to minimize exposure to ionizing radiation as well.
These descriptions must be typewritten.

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"To the best of my knowledge, this application is complete and accurate. All individuals who will work under this
permit has been properly trained in the use and handling of radioactive materials."

Authorized User's signature: _____ Date: _____

RSO's signature: _____ Date: _____

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APPENDIX VII

RADIOACTIVE MATERIAL REQUEST FORM

Return this form to the RSO by 3:00 p.m. for same-day ordering.

Name: _____Authorized User: _____

Building: _____ Room #: _____

Vendor: _____ Date item(s) needed by: _____

Contact Phone #: _____ Email: _____

P.O. number: _____ Date: _____

Purchase Card: _____ Approved by: _____

Qty.	Radionuclide	Chemical Form	Vendor	Catalog #

Receipt (RSO use only)

Date of receipt: _____ User: _____

Package condition: Okay _____ Damaged/ Wet _____

Nuclide: _____ Chemical form: _____ Activity: _____mCi

Transport Label: None o White o Yellow-II o Calibration Date: _____

External Rad. Surface level: _____mR/hr Background_____mR/hr

Background wipe: _____ Package Wipe: _____

Lab Receipt Signature_____

Comments:

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APPENDIX VIII

STATEMENT OF RECEIPT OF RADIOACTIVE MATERIALS

This statement must be completed by an individual authorized to accept shipment of radioactive materials by the Radiation Safety Office.

Copies of the completed form and the shipping paper must be retained by RSO and Authorized user for records

Record the following information, one form per package. **ALL INFORMATION IS REQUIRED**.

Receipt date: _____ Receipt time: _____
Nuclide: _____ Activity received (mCi/µCi): _____
Chemical form: _____ Physical form: _____
Volume: _____ Storage Location: _____
Vendor: _____ Lot/Purchase order number:
_____
Principal Investigator: _____
Exposure, contact in mR/hr: _____ Wipe test in DPM: _____
Exposure, 3 feet in mR/hr: _____
Package Type: _____ (LQ, WI, YII, YIII) *

Person receiving: _____
Signature: _____
Comments:
_____

Exposure is measured with a Geiger-Mueller (GM) pancake probe-equipped survey meter in a low background area. Exposure on contact is highest on surface of package exterior. Exposure at 3 feet is highest measured at any point 3 feet from package.

A wipe test is conducted wiping a filter paper over 300 cm^2 (about a 7" by 7" area) of the package exterior. Count the wipe test with a liquid scintillation counter.

*LQ is a package with no label; respectively, W1 is a white 1; YII is a yellow II, and YIII is a yellow III labeled package.

Notify the RSO at Ext 2243 immediately if a package appears damaged, leaking, or the wipe test is greater than 3,000 DPM.

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APPENDIX IX

Special Instructions to Central Receiving and Campus Police

The University of North Texas Health Science Center is licensed by the Texas Department of State Health Services, Bureau of Radiation Control to possess certain quantities of radioactive material. In accordance with our license agreement, all radioactive materials shipped to the health science center are sent to the following address:

Attn.: Radiation Safety Office
UNTHSC Central Receiving
3420 Darcy Street
Fort Worth, Texas 76107

Packages containing radioactive materials shall be delivered to or picked up by the Radiation Safety Officer (RSO) or staff of the RSO UNOPENED within 3 hours of receipt if received during normal business hours. UNTHSC receiving personnel shall notify the Radiation Safety Officer (Safety Office, ext. 2697) promptly. Packages delivered after hours, weekends and holidays shall be delivered to the Safety Office no later than 3 hours from the beginning of the next working day, as described in 25 TAC 289.202(ee)(3). Items on dry ice or marked perishable or refrigerated upon arrival shall be handled by all personnel according to the package markings.

Packages may not be co-mingled in refrigerators or freezers with items for human consumption. Personnel in the Safety Office shall sign for packages. Central Receiving shall be notified by the Radiation Safety Officer in the event of duplicate shipments, damaged goods, or discrepancies in quantities. This procedure is intended to protect receiving personnel from unnecessary exposure to ionizing radiation.

Personnel should examine the exterior of all packages from these vendors and the packing slip, if affixed to the exterior of the package, for an indication that the material is radioactive. Not all packages from these vendors will contain radioactive materials. If the package contains any ONE of the labels or words on its exterior as specified in Figure 8.1 (Appendix IX), the package should be delivered to the Radiation Safety Officer, UNOPENED.

Shaded areas on the labels shown above will appear in yellow, and the hash marks next to the word “Radioactive” will appear in red. Not shown is the label with no red mark. The redder the marks, the greater the radiation hazard. Receiving personnel MUST notify the Radiation Safety Officer immediately if a package is received with **three red stripes**.

Deliveries during holidays, severe weather, and on weekends

In the event that the health science center is closed for a planned holiday during a weekday, Central Receiving shall affix a notice to the exterior of the loading dock door addressed to commercial carriers directing them to deliver all radioactive materials to the Campus Police

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station. In the event of a severe weather closing, Campus Police are directed to affix the notice to the exterior of the loading dock door directing vendors to deliver all radioactive materials to the Campus Police station. Deliveries of radioactive materials on the weekend is not routine. In the event that a commercial carrier makes a delivery of radioactive material on the weekend, the package should be received by Campus Police. The Radiation Safety Officer shall be notified immediately of such deliveries. Campus Police maintains a card file with the Radiation Safety Officer's home phone and digital pager number. If the RSO cannot be reached, Campus Police are directed to call the home of or page the Assistant Radiation Safety Officer.

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APPENDIX X

UNTHSC Radioactive Material Transfer Form

1. All radioactive transfers must be approved by the Radiation Safety Officer (RSO).
2. Complete this transfer form in its entirety. If the form is not completed, requests will be delayed.
3. Prior to isotope transfer, transfer request forms must be received by the Environmental Health and Safety Office and approved by RSO.
4. Mail or email the completed form to safety@unthsc.edu, Call 817-735-2243 if you have questions

Authorized User (first and last name):	Department:	
Transfer Institution:		
Person to Contact if Questions:	Contact Person #:	Delivery Address (bldg. and room):
Receiving Authorized User	Dept:	Phone #:
Receiving Institution:		
Transfer Request	Only **one** item per row may be listed on this form.	

#	Radiolabeled Substance/Compound	Isotope	Quantity	Unit Activity (mCi)	Requested Delivery Date
1					
2					
3					
4					
5					
6					

Acceptable isotope transfer delay days? _____
Requested Date: _____ Requesting Person's Signature: _____
Notes:
RSO/ARSO Signature: _____ Date: _____

APPENDIX XI

PREGNANCY DECLARATION

To control radiation dose to the fetus/embryo from occupational exposure, pregnant women must declare their pregnancy to their employer in writing (25 TAC 289.202(m), which references NRC regulations 10 CFR20.1003 and 20.1208). This allows the employer to apply the fetal dose limits outlined in 20.1208.

To: Radiation Safety Officer/ Office

From: Full Name: _____ DOB: _____

UNTHSC Employee #: _____ Telephone: _____

Department: _____Email Address: _____

Signature: _____ Date: _____

I hereby notify The University of North Texas Health Science Center at Fort Worth that I am pregnant or intend to become pregnant. I would like to arrange a Radiation Safety consultation.

My anticipated delivery date: _____My anticipated conception date: _____

Currently work laboratory(s):

_____

Radioactive Materials or X-Ray Unit: _____

AU/PI* _____ Email: _____

Telephone: _____ Department: _____

Signature of the person declaring pregnancy: _____ Date: _____

***Authorized User/Principal Investigator**

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APPENDIX XII
RUNNING RADIOISOTOPE INVENTORY

Isotope: _____ Manufacturer: _____

Chemical form: _____ Lot number: _____

Physical form: _____ Assay date: _____

Storage location: _____ Amount (µCi/mCi): _____

Volume: _____

Comments:_ Signature: _____

_____
_____
_____

Date	Amount used (µCi/mCi)	Amount on hand (µCi/mCi)	Disposal method	Initials

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APPENDIX XIII

QUARTERLY SUMMARY REPORT OF ISOTOPE INVENTORY

(Please print clearly)

Authorized User: _____ Location of Isotope: _____

Inventory reported by: _____ Inventory Date: _____

Signature: _____ Report for: 1st, 2nd, 3rd, 4th quarter 20__

Isotope	Amount Purchased this quarter (µCi)	Amount used this quarter (µCi)	Amount on hand at end of quarter (µCi)	Loss due to decay (µCi)	Solid waste transferred to RSO (µCi)	Liquid waste transferred to RSO (µCi)	Sanitary sewer (µCi)
^{3}H							
^{14}C							
^{32}P							
^{33}P							
^{35}S							
^{125}I							
^{18}F							
^{22}Na							
^{152}Eu							
^{137}Cs							
^{51}Cr							
^{64}Cu							

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APPENDIX XIV
MONTHLY WIPE TEST

Authorized User: _____Instrument make & Model: __

Person conducting test: _____Instrument ID: _____

Radioisotope monitored: _____ Instrument efficiency: _____
(Specify for each radioisotope)

Location	CPM/DPM	CPM/DPM After cleaning	Date
Background			

You are required to monitor work areas after every single experiment. You are required to report your result in DPM. Background counts are required. Clean all surfaces with more than twice background. Report results after cleaning contaminated surfaces.
CPM/Efficiency = DPM contamination in dpm = DPM (sample) – DPM (background)
Radioisotopes were used during _____ and the work area was monitored as required.
(month & year)
No radioisotopes were used during _____, therefore surveys were not performed.
(month & year)

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APPENDIX XV

REQUEST FOR RADIATION BADGE FORM

Instructions: Please supply the information requested below. Upon completion of this form, return it to the Radiation Safety Office or safety@unthsc.edu. An appropriate monitoring device will be issued by the Radiation Safety Officer. Please print or type on this form*. (*Required).*

*Name: Last _____ *First _____*Middle _____

*Date of Birth: _____ *EUID #: _____ *Sex (M/F) ____

*Department: _____ *Office Phone #: _____

*Your Position: _____ *Radioisotope/Device to be monitored _____

*Name of AU/ Supervisor: _____

Radiation Exposure History

*Have you ever been issued a dosimeter at HSC? Yes ___ No ___

*Have you been previously monitored while working elsewhere? Yes ___ No ___

(If you answered yes, please supply the information requested below for your last job for which you were monitored)

Company: _____ From: _____ To: _____

Address: _____ _____

City: _____ State: _____ Zip Code: _____

_____ _____

*Signature of Radiation Worker *Date

_____ _____

*Signature of Supervisor *Date

Radiation Safety Official Use Only

Date issued: _____ Group: _____ Participant #: _____

*AU – Authorized User

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To:

Company: _____

Address:_____

City: _____ State: _____ Zip Code: _____

From:

Name:
Radiation Safety Office
Office of Environmental Health & Safety Subject:

Request for Radiation Exposure History

To Whom It May Concern:

The person listed below worked at your institution and has disclosed that he/she was monitored for radiation exposure while doing so. UNTHSC request to know about this person's history of radiation exposure while working at your institution to comply with the rules of 10CFR20. Include any bioassay, if any, results that helped determine the effective dose equivalent that person may have received. Name: Last _____ First _____ MI _____

From: _____ To: _____

Please forward report to:
UNTHSC
3500 Camp Bowie Blvd
Attn: Radiation Safety Officer
Office of Environmental Health & Safety
Fort Worth, TX 76107

Sincerely, Name:
Radiation Safety Officer

Authorization for release of confidential radiation exposure records.

To whom it may concern:
I hereby authorize and request that my records of radiation exposure history be released to Radiation Safety Office at UNTHSC.

Full Name: _____

_____ _____
Signature Date

APPENDIX XVI

RADIOACTIVE ANIMAL(S) CAGE TAG

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APPENDIX XVII

RADIOACTIVE ANIMAL(S) WASTE TAG

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APPENDIX XVIII

§289.202(ggg)(7)

Concentration and activity limits of nuclides for disposal in a Type I municipal solid waste site or a hazardous waste facility (for use in subsection (fff) of this section). The following table contains concentration and activity limits of nuclides for disposal in a Type I municipal solid waste site or a hazardous waste facility.

Nuclides	Concentrations Limit (Ci/m3)	Annual Generator Disposal Limit (Ci/yr)
F-18	3 x 10-1	8
Si-31	1 x 10+2	3 x 10+3
Na-24	9 x 10-4	2 x 10-2
P-32	2	5 x 10+1
P-33	10	3 x 10+2
S-35	9	2 x 10+2
Ar-41	3 x 10-1	8
K-42	2 x 10-2	5 x 10-1
Ca-45	4	1 x 10+2
Ca-47	2 x 10-2	5 x 10-1
Sc-46	2 x 10-3	5 x 10-2
Cr-51	6 x 10-1	2 x 10+1
Fe-59	5 x 10-3	1 x 10-1
Co-57	6 x 10-2	2
Co-58	1 x 10-2	3 x 10-1
Zn-65	7 x 10-3	2 x 10-1
Ga-67	3 x 10-1	8
Se-75	5 x 10-2	1
Br-82	2 x 10-3	5 x 10-2
Rb-86	4 x 10-2	1
Sr-85	2 x 10-2	5 x 10-1
Sr-89	8	2 x 10+2
Y-90	4	1 x 10+2
Y-91	4 x 10-1	10
Zr-95	8 x 10-3	2 x 10-1
Nb-95	8 x 10-3	2 x 10-1
Mo-99	5 x 10-2	1
Tc-99m	1	3 x 10+1
Rh-106	1	3 x 10+1
Ag-110m	2 x 10-3	5 x 10-2
Cd-115m	2 x 10-1	5
In-111	9 x 10-2	2

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In-113m	9	2 x 10+2
Sn-113	6 x 10-2	2
Sn-119	2 x 10+1	5 x 10+2
Sb-124	2 x 10-3	5 x 10-2
Te-129	2 x 10-1	5
I-123	4 x 10-1	1 x 10+1
I-125	7 x 10-1	2 x 10+1
I-131	4 x 10-2	1
I-133	2 x 10-2	5 x 10-1
Xe-127	8 x 10-2	2
Xe-133	1	3 x 10+1
Ba-140	2 x 10-3	5 x 10-2
La-140	2 x 10-3	5 x 10-2
Ce-141	4 x 10-1	1 x 10+1
Ce-144	1 x 10-3	3 x 10-2
Pr-143	6	2 x 10+2
Nd-147	7 x 10-2	2
Yb-169	6 x 10-2	2
Ir-192	1 x 10-2	3 x 10-1
Au-198	3 x 10-2	8 x 10-1
Hg-197	8 x 10-1	2 x 10+1
Tl-201	4 x 10-1	1 x 10+1
Hg-203	1 x 10-1	3

NOTE: In any case where there is a mixture in waste of more than one radionuclide, the limiting values for purposes of this paragraph shall be determined as follows:

For each radionuclide in the mixture, calculate the ratio between the quantity present in the mixture and the limit established in this paragraph for the specific radionuclide when not in a mixture. The sum of such ratios for all the radionuclides in the mixture may not exceed "1" (i.e., "unity").

Examples: If radionuclides a, b, and c are present in concentrations Ca, Cb, and Cc, and if the applicable concentrations are CLa, CLb, and CLc respectively, then the concentrations shall be limited so that the following relationship exists:

$$(Ca/CLa) + (Cb/CLb) + (Cc/CLc) \leq 1$$

If the total curies for radionuclides a, b, and c are represented Aa, Ab, and Ac, and the annual curie limit for each radionuclide is ALa, ALb, and ALc, then the generator is limited to the following:

$$(Aa/ALa) + (Ab/ALb) + (Ac/ALc) \leq 1$$

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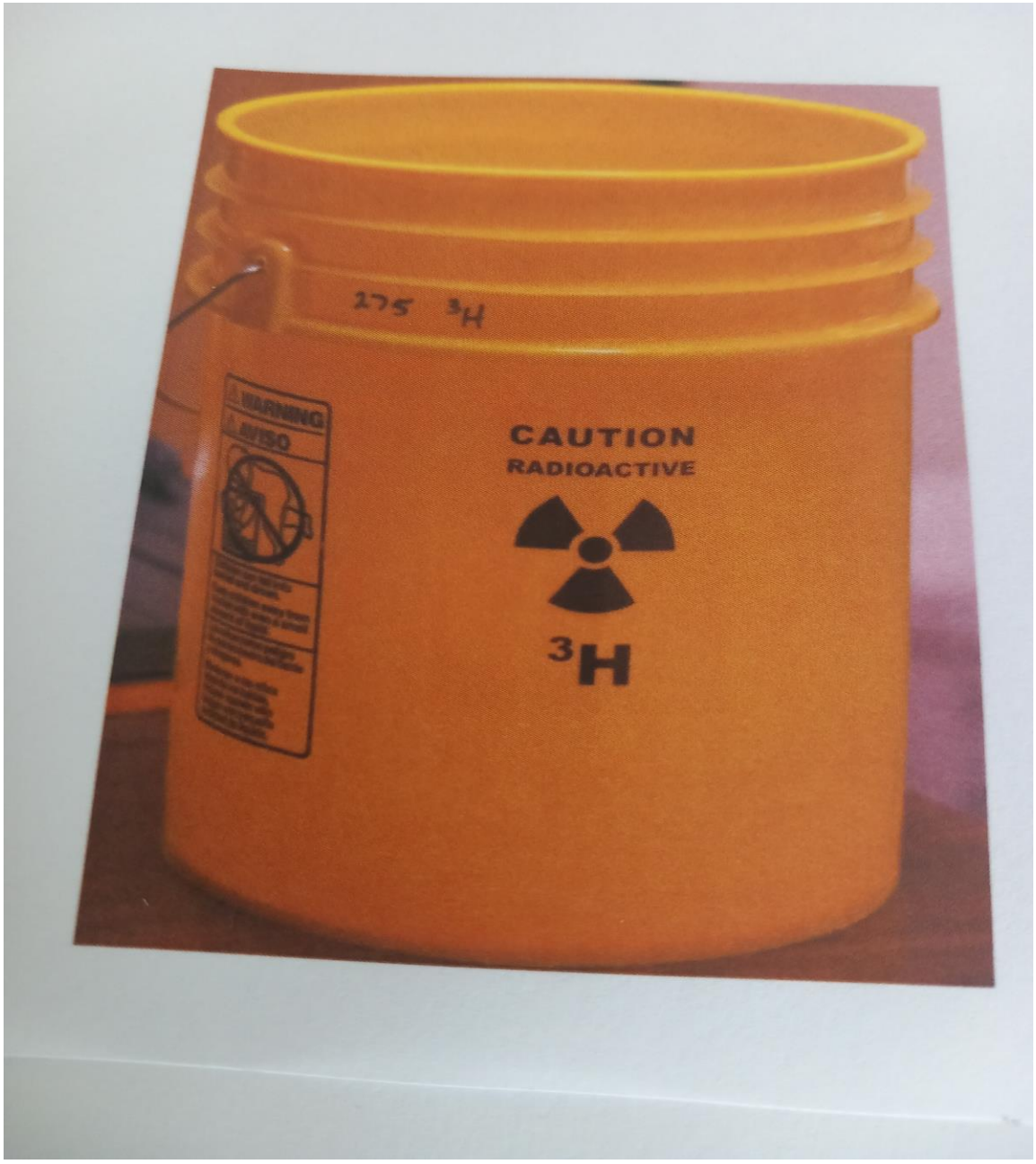
APPENDIX XIX

RADIOACTIVE WASTE BUCKET AND STICKER



RADIOACTIVE WASTE MATERIAL

LABORATORY _____ Room ____
LAB Supervisor _____
Phone Number _____

Isotope: _____ Symbol _____
Chemical form
Total Radiation Level _____
Maximum DPMs
Date the isotopes are no longer active and can be discarded: _____

Type of Waste Material:
1. Liquid Waste (Low DPMs) _____ mCi.
2. Liquid Waste (High DPMs) _____ mCi.
3. Solid Waste _____ mCi.
4. Scintillation Vials _____ mCi.

_____
Signature of Lab Supervisor.

_____ _____
Date of Transfer Received by:

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APPENDIX XX

RADIOACTIVE WASTE MATERIAL TRANSFER FORM

AU: _____

Lab #: _____

Phone: _____

Department: _____

Isotope: _____

Total quantity (µCi): _____

Description and Amounts: _____

_____

_____

_____

_____

_____

_____

Signature of Laboratory Supervisor

_____ _____

Date of Transfer Received by

Comments: _____

_____

_____

_____

_____

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APPENDIX XXI

MONTHLY SINK DISPOSAL FORM

Location: _____ Authorized user: _____

Isotope	Daily Disposal Limits	μCi^{-day}

Date	Initials	Faculty	Isotope	µCi

Isotope		µCi

By appending your initials, you certify that this record is accurate and complete:

_____
Authorized user signature

_____
Date

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APPENDIX XXII

PROGRESSIVE DISCIPLINE FOR MONTHLY AREA SURVEYS

Monthly area surveys reporting requirements and discipline

Adopted by Radiation Safety Committee

UNT Health Science Center at Fort Worth, TX.

April 11, 2024

Scope: This policy applies to all active, authorized users and their research groups.

Definitions

Active authorized user or research group — is an authorized user and their research group that has not been placed on inactive status.

Authorized user — means a person whose name appears on the institutional radioactive materials license as an authorized user of radioactive materials.

Inactive status — an authorized user whose research group does not possess radioactive materials or use radioactive materials on a routine basis, and who has requested inactive status in writing and such status has been granted by the RSO.

RSO —the radiation safety officer is the person named on the institutional radioactive materials license to act as the RSO.

Background

Frequent reviews of area surveys and additional discipline procedures are required to maintain an adequate level of compliance with the area survey requirements of the institutional radioactive materials license. It is a requirement of the radioactive materials license that authorized users complete or cause to be completed monthly area surveys of all posted areas under their control. It is a requirement that each authorized research group review their activities on a monthly basis and that they generate written evidence of the monthly review:

1) In the case of areas where isotopes were used, documentation that wipe tests were performed is required;

2) In areas where no isotopes were used for the month, a form stating no isotopes were used in that area is required.

On or by the end of business (5 PM) on the 3rd working day of each month, but no sooner than the 1st working day of each month, each authorized user shall submit or cause to be submitted the following paperwork to the RSO's for review:

1) At least one appropriately completed wipe test form FOR EACH room (laboratory) under their control where radioactive materials may be used or stored, the surveys having been performed in the preceding month. Attached scintillation counter/gamma counter raw data with the form when reporting wipe tests for areas were isotopes were used during the previous month.

2) If isotopes were used in an area between the first day of the previous month and the last day of the previous month, in addition to the required wipe test form, a copy of the map for each surveyed area shall also be submitted. Maps shall denote isotope use areas and nonuse areas and where wipe test samples were taken for analysis, both in the use areas and non-use areas of the lab.

3) A form must be submitted for each room in which isotopes could have been used (posted areas) but were not used for the month. Document on the wipe test form that isotopes were not used in that room for that month as provided on the form. In the event the 3rd working day is an official holiday of the organization, or the authorized user has informed the RSO in advance that such date conflicts with a religious observance day taken by the authorized user in lieu of another official holiday, the deadline for submitting the required paperwork shall be extended to the end of business on the next business day.

Policy enforcement and discipline

Enforcement of this policy is a shared responsibility of authorized users, the RSO acting as the agent of the RSC, and senior administration of the health science center. Discipline shall be progressive in nature. The purpose of discipline is to protect human health and to prevent recurrence of violation of this policy.

Research group discipline

When the RSO detects a violation of this policy, the research group that does not submit the required timely reports to the RSO's office can expect: first offense, 30-day suspension of ordering and receiving privileges; second offense, 60-day suspension of ordering and receiving privileges; third offense, loss of all privileges in the radioactive materials program, with reapplication to the RSC required.

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APPENDIX XXIII

REVISED VERSION

Monthly area surveys reporting requirements and discipline. Adopted by Radiation Safety Committee UNT Health Science Center at Fort Worth April 11, 2024.

IT IS REQUIRED TO SUBMIT THE WIPE TEST DOCUMENT MONTHLY IN A TIMELY MANNER, EVEN IF YOU ARE NOT USING ANY ISOTOPE DURING THAT MONTH. Violation of this policy and procedure will lead to the following disciplinary actions for the authorized user for radioisotope and his/ her laboratory personnel.

First Offense, 30 days suspension of ordering and receiving privileges; The RSC will require the authorized user and his/her laboratory personnel to retake the online radiation safety training. The radiation safety training must be completed within 30 days of the notification of violation.

Second Offense, 60 days suspension of ordering and receiving privileges; The RSC will require the authorized user and his/her laboratory personnel to retake the online radiation safety training. The radiation safety training must be completed within 30 days of the notification of violation.

Third offense, loss of all privileges in the radioactive materials program, with reapplication to the RSC required. The RSC will require the authorized user and his/her laboratory personnel to retake the online radiation safety training. The radiation safety training must be completed within 30 days of the notification of violation.

Authorized user discipline Authorized users whose research group loses all privileges in the radioactive materials program under this policy (a third offense detected by the RSO) shall be referred to the College Dean/Department Chair for discipline under the faculty by-laws. After the discipline has been administered, the faculty member may re-apply to the RSC for privileges.

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APPENDIX XXIV

PROHIBITED USE OF ^{3}H

The table below is to assist Authorized Users and their staff to comply with the limitations on the use of tritium compounds at HSC. The following quantities and patterns of use, if met or exceeded, would require routine bioassays for tritium. Work with such materials at these levels is not currently authorized.

Chemical Form	Action Level*	Working Situation
Tritiated water & nucleotide precursors	100 mCi	work at the laboratory bench
Tritium in gaseous form	any quantity	any working condition
Tritiated water & nucleotide precursors	1,000 mCi	work at the chemical fume hood with potential to release tritium compounds**

*The action level is the amount requiring routine bioassay in the following patterns of use: 1) the amount handled at any one time by an individual who uses tritium on an infrequent basis, or 2) the cumulative amount of activity handled during any one month when small amounts of tritium are used on a frequent basis.

** Potential to release means that the possibility of a significant airborne release of radioactive material exists because 1) the techniques used to process the material may create an aerosol, 2) the material is inherently volatile, or 3) the techniques used to process the material may increase its volatility.

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APPENDIX XXV

PROHIBITED USES OF RADIOIODINE (^{125}I AND ^{131}I)

The table below is to assist Authorized Users and their staff to comply with the limitations on the use of radioactive iodine compounds at HSC. The following quantities and patterns of use, if exceeded, would require routine bioassays. Work with such materials at these levels is not currently authorized.

Chemical Form	Action Level*	Working situation
Volatile (e.g... NaI)	1mCi	work at the laboratory bench
Bound forms (e.g... iodinated proteins)	10mCi	work at the laboratory bench
Volatile (e.g... NaI)	10mCi	work in the chemical fume hood with potential release of compounds**
Bound forms (e.g... iodinated proteins)	100mCi	work in the chemical fume hood with potential release of compounds**
Volatile (e.g... NaI)	100mCi	work in glove box with iodine trap under the chemical fume hood
Bound forms (e.g... iodinated proteins)	100mCi	work in glove box with iodine trap under the chemical fume hood

*The action level is the amount requiring routine bioassay and is considered to be the cumulative quantity handled by an individual during a 3-month period or on one or more occasions in that period by opening stock reagent containers from which radioiodine may escape.

**Potential release means that the possibility of a significant airborne release of radioactive material exists because 1) the techniques used to process the material may create an aerosol, 2) the material is inherently volatile, or 3) the techniques used to process the material may increase its volatility.

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APPENDIX XXVI

RADIOISOTOPE USAGE HISTORY FOR UNUSED ISOTOPE THAT IS STORED FOR MORE THAN 2 YEARS

Adopted by Radiation Safety Committee UNT Health Science Center at Fort Worth Adopted: April 11, 2024

Isotope: _____ Manufacturer: _____

Chemical form: _____ Lot #: _____

Physical form: _____ Assay date: _____

Storage location: _____ Amount (µCi/mCi): _____

Authorized user: _____ Volume: _____

Date of last use	
Amount in hand (µCi/mCi)	
Justification and proposed plan for future use	

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APPENDIX XXVII

CONDITIONS FOR DOSIMETRY

Radioisotope(s)	Activity, mCi	Type of Monitoring
^{14}C, ^{3}H,	any amount	None required
Low Energy Gamma Ray Emitters, < 200 keV (^{125}I, ^{99m}Tc)	< 50 mCi	None required
	≥ 50 mCi	Ring and whole-body dosimeters
High Energy Gamma Ray Emitters, ≥ 200 keV (^{51}Cr, ^{131}I, ^{60}Co, ^{137}Cs)	< 2 mCi	None required
	≥ 2 mCi to < 5 mCi	Ring dosimeter
	≥ 5 mCi	Ring and whole-body dosimeter

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APPENDIX XXVIII

SAFETY DATA FOR COMMONLY USED RADIONUCLIDE

Radionuclide	Radiation(s) emitted and energy (MeV)	Radiological Half-Life	Critical Organ	Max. Beta Range in Air / Water	Detection & Measurement (Contamination)	Maximum Permissible Body Burden	Shielding Required (cm)
^{3}H	Beta particle: Emax -0.186 Emean – 0.0057	12.3 years	whole body	1 cm 0.001 cm	Hand-held: windowless gas-flow proportional Non-portable: LSC	1000 µCi whole body	None
^{14}C	Beta Emax 0.156 Emean 0.049	5730 years	Whole Body, Fat, Bone	30 cm 0.03 cm	Hand-held: gas-flow proportional Non-portable: LSC	400 µCi whole body 300 µCi fat	None
^{18}F	*EC Emax 0.633 Emean 0.250	109.74 mins	Whole body	178 cm 0.02 cm	Hand-held: gas-flow proportional, Non-portable: LSC, NaI well counter	20 µCi whole body	Concrete 0.83 cm Lead 0.01 cm
^{22}Na	Beta Emax 0.546	2.605 years	Whole Body	176 cm 0.2 cm	Hand-held: gas-flow proportional, Non-portable: LSC, NaI well counter	10 µCi whole body	
^{51}Cr	Gamma photon: 0.320	27.7 days	Lower Large Intestine	N/A cm N/A cm	Hand-held: NaI scintillator Non-portable: NaI well counter	800 µCi whole body	
^{64}Cu	EC Emax 0.578 & 0.653 Emean 0.19 Positrons: 0.278	12.701 hours	Whole body	240 cm 0.25 cm	Hand-held Ludlum 3 w/ pancake probe at 1 cm Non-portable: LSC, NaI well counter	80 µCi whole body	Plastic 0.25 cm Aluminum 0.1
^{68}Ge	Beta -1.899 γ 0.511 MeV	270.95 days	kidney			100 µCi kidney	Glass: 0.39 plastic: 0.72 Lead: 0.72
^{99m}Tc	Beta: 0.1195, 0.0155 Gamma 0.1405	6.01 hours	Whole body	N/A cm N/A cm	Hand-held: NaI scintillator Non-portable: LSC, NaI well counter	70 µCi whole body	Glass: 0.02 cm plastic: 0.03 Lead: 0.04, Steel: 0.81, Concrete: 0.84
^{125}I	EC 0.0275 MeV 0.0272 MeV	60.0 days	Thyroid	N/A cm N/A cm	Hand-held: NaI scintillator Non-portable: LSC, NaI well counter	1 µCi thyroid	Lead 0.002, Steel: 0.009, Concrete: 0.31
^{137}Cs	Beta: Emax 0.512 & 1.173 Gamma: 0.662	30.08 years	Whole body	130 cm 1.5 cm	Hand-held: NaI scintillator Non-portable: LSC, NaI well counter	30 µCi whole body	Glass: 0.21 Plastic: 0.38 Lead: 0.94, Steel: 3.8 Concrete: 12.1
^{152}Eu	Emax 0.388, 0.699, 1.478		Kidney			Kidney 20 µCi Whole body 30 µCi	

EC = Electron capture:, LSC = Liquid scintillation counter

APPENDIX XXIX

RADIATION EMERGENCY RESPONSE GUIDELINES

KIND OF EMERGENCY	HAZARD	IMMEDIATE PRECAUTIONS	FOLLOW-UP
Minor Spills (Usually micro-curie amounts)	Radiation: No immediate radiation hazard to personnel. Contamination: Low	• Notify all persons in room. • Confine spill immediately. • Notify Radiation Safety Officer (RSO).	Permit no one to work in area until approved by Radiation Safety Officer (RSO).
Major Spills (Usually milli-curie amounts)	Radiation: No immediate radiation hazard to personnel. Contamination: Low	• Notify others in room or area to vacate. • Confine spill immediately. • Make no attempt to clean up spill. • Switch OFF all fans and close all windows. • Vacate room or area. • Provide temporary barricade and warning signs. • Notify RSO.	Decontamination of personnel and equipment (including spill) to be carried out by or under supervision of RSO.
Accident Involving: - Dust - Mist - Fumes - Vapors - Gases	Radiation: No immediate radiation hazard to personnel. Contamination: Low	• Notify others in room or area to vacate. • Switch OFF all fans and close all windows. • Vacate room or area. • Provide temporary barricade and warning signs. • Notify RSO.	Do not re-enter until approved by RSO.
Minor Injuries Involving: - Radiation Hazard - Contamination	Contamination: Wounds usually greatest hazard.	• Wash wound immediately in running water. • Call physician of choice. • Notify RSO.	Permit no one involved in accident to return to work until approved by RSO and physician.
Major Injuries Involving: - Radiation Hazard - Contamination	Contamination: Wounds usually greatest hazard.	• Life threatening situations take precedence over contamination control.	Permit no one involved in an accident to return to work until approved by RSO and physician.
Fires involving: - Radioactivity	Radiation: No immediate radiation hazard to personnel. Contamination: Low	• Notify others in room and building to vacate. • Attempt to extinguish fire if no radiation hazard & can be safely done. • Call Campus Police ASAP (911). • Notify RSO.	Emergency activities will be governed by or in cooperation with RSO. Campus Police will determine whether local Fire Department is to be called.

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SECTION IV
DEFINITIONS

Absorbed dose--The energy imparted by ionizing radiation per unit mass of irradiated material. The units of absorbed dose are the gray (Gy) and the rad.

Activity--The rate of disintegration or transformation or decay of radioactive material. The units of activity are the becquerel (Bq) and the curie (Ci).

Adult--An individual 18 or more years of age.

Agency--The Department of State Health Services.

Approved individual--An individual whom the licensee has determined to be trustworthy and reliable for unescorted access in accordance with §289.252(ii)(2) - (8) of this title (relating to Licensing of Radioactive Material) and who has completed the training required by §289.252(ii)(10)(C) of this title.

Background radiation--Radiation from cosmic sources; non-technologically enhanced naturally occurring radioactive material, including radon, except as a decay product of source or special nuclear material, and including global fallout as it exists in the environment from the testing of nuclear explosive devices or from past nuclear accidents, such as Chernobyl, that contribute to background radiation and are not under the control of the licensee. "Background radiation" does not include radiation from sources of radiation regulated by the agency.

Becquerel (Bq)--The International System of Units (SI) unit of activity. One becquerel is equal to 1 disintegration or transformation per second (dps or tps). Commonly used multiples of the becquerel are the kBq (kilobecquerel, 10^3 Bq), MBq (megabecquerel, 10^6 Bq), GBq (gigabecquerel, 10^9 Bq), and TBq (terabecquerel, 10^{12} Bq). 1 Ci = 37 GBq.

Bioassay--The determination of kinds, quantities, or concentrations, and, in some cases, the locations of radioactive material in the human body, whether by direct measurement, in vivo counting, or by analysis and evaluation of materials excreted or removed from the human body. For purposes of this chapter, "radiobioassay" is an equivalent term.

Curie (Ci)--A unit of measurement of radioactivity. One curie (Ci) is that quantity of radioactive material that decays at the rate of 3.7×10^{10} disintegrations per second (dps). Commonly used submultiples of the curie are the millicurie (mCi) and the microcurie (µCi). One mCi = 1×10^{-3} Ci = 3.7×10^7 dps. One µCi = 1×10^{-6} Ci = 3.7×10^4 dps. One nanocurie (nCi) = 1×10^{-9} Ci = 3.7×10^1 dps. One picocurie (pCi) = 1×10^{-12} Ci = 3.7×10^{-2} dps.

Decommission--To remove a facility or site safely from service and reduce residual radioactivity to a level that permits the following:

(A) release of the property for unrestricted use and/or termination of license; or

(B) release of the property under alternate requirements for license termination.

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Dose--A generic term that means absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, total organ dose equivalent, or total effective dose equivalent. For purposes of this chapter, "radiation dose" is an equivalent term.

Dose limits--The permissible upper bounds of radiation doses established in accordance with this chapter. For purposes of this chapter, "limits" is an equivalent term.

Embryo/fetus--The developing human organism from conception until the time of birth.

Entrance or access point--Any opening through which an individual or extremity of an individual could gain access to radiation areas or to licensed sources of radiation. This includes portals of sufficient size to permit human access, irrespective of their intended use.

Exposure rate--The exposure per unit of time.

External dose--That portion of the dose equivalent received from any source of radiation outside the body.

Extremity--Hand, elbow, arm below the elbow, foot, knee, and leg below the knee. The arm above the elbow and the leg above the knee are considered part of the whole body.

Gray (Gy)--The SI unit of absorbed dose. One gray is equal to an absorbed dose of 1 joule per kilogram (J/kg) or 100 rad.

Individual--Any human being.

Inspection--An official examination and/or observation including, but not limited to, records, tests, surveys, and monitoring to determine compliance with the Act and rules, orders, requirements, and conditions of the agency.

Internal dose--That portion of the dose equivalent received from radioactive material taken into the body.

Ionizing radiation--Any electromagnetic or particulate radiation capable of producing ions, directly or indirectly, in its passage through matter. Ionizing radiation includes gamma rays and x-rays, alpha and beta particles, high-speed electrons, neutrons, and other nuclear particles.

Lens dose equivalent--The external dose equivalent to the lens of the eye at a tissue depth of 0.3 cm (300 mg/cm^2).

License--A form of permission given by the agency to an applicant who has met the requirements for licensing set out in the Act and this chapter.

Licensed material--Radioactive material received, possessed, used, or transferred under a general or specific license issued by the agency.

Licensee--Any person who is licensed by the agency in accordance with the Act and this chapter.

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Licensing state--Any state with rules equivalent to the Suggested State Regulations for Control of Radiation relating to, and having an effective program for, the regulatory control of naturally occurring or accelerator-produced radioactive material (NARM) and has been designated as such by the Conference of Radiation Control Program Directors, Inc. For the purposes of evaluation and/or distribution of sealed sources, this includes Licensing State Status: Product Review Only.

Member of the public--Any individual, except when that individual is receiving an occupational dose.

Monitoring--The measurement of radiation, radioactive material concentrations, surface area activities, or quantities of radioactive material and the use of the results of these measurements to evaluate potential exposures and doses. For purposes of this chapter, "radiation monitoring" and "radiation protection monitoring" are equivalent terms.

Natural radioactivity--Radioactivity of naturally occurring nuclides whose location and chemical and physical form have not been altered by man.

NRC--The United States Nuclear Regulatory Commission or its duly authorized representatives.

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

Public dose--The dose received by a member of the public from exposure to sources of radiation released by a licensee, or to any other source of radiation under the control of a licensee/registrant. It does not include occupational dose or doses received from background radiation, from any medical administration the individual has received, from exposure to individuals administered radioactive material and released in accordance with this chapter, or from voluntary participation in medical research programs.

Radiation--One or more of the following:

(A) gamma and x-rays; alpha and beta particles and other atomic or nuclear particles or rays;

(B) emission of radiation from any electronic device to such energy density levels as to reasonably cause bodily harm; or

(C) sonic, ultrasonic, or infrasonic waves from any electronic device or resulting from the operation of an electronic circuit in an electronic device in the energy range to reasonably cause detectable bodily harm.

Radiation area--Any area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.005 rem (0.05 mSv) in one hour at 30 cm from the source of radiation or from any surface that the radiation penetrates.

Radiation machine--Any device capable of producing ionizing radiation except those devices with radioactive material as the only source of radiation.

Radiation safety officer (RSO)--An individual who has a knowledge of and the authority and responsibility to apply appropriate radiation protection rules, standards, and practices, who must be specifically authorized on a radioactive material license, and who is the primary contact with the agency.

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

Radioactive waste--For purposes of this chapter, this term is equivalent to Low Level Radioactive Waste (LLRW).

Radioactivity--The disintegration of unstable atomic nuclei with the emission of radiation.

Radiobioassay (See definition for bioassay.)

Regulations of the United States Department of Transportation (DOT)--The requirements in Title 49, CFR, Parts 100 - 189.

Rem--The special unit of any of the quantities expressed as dose equivalent. The dose equivalent in rem is equal to the absorbed dose in rad multiplied by the quality factor (1 rem = 0.01 sievert (Sv)).

Roentgen (R)--The special unit of exposure. One roentgen (R) equals 2.58×10^{-4} C/kg of air. (See definition for exposure rate.)

Sealed source--Radioactive material that is permanently bonded or fixed in a capsule or matrix designed to prevent the release and dispersal of the radioactive material.

Sievert--The SI unit of any of the quantities expressed as dose equivalent. The dose equivalent in sievert is equal to the absorbed dose in gray multiplied by the quality factor (1 Sv = 100 rem).

Source of radiation--Any radioactive material, or any device or equipment emitting or capable of producing radiation.

Survey--An evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal, and/or presence of sources of radiation. When appropriate, such survey includes but is not limited to, tests, physical examination of the location of materials and equipment, measurements of levels of radiation or concentration of radioactive material present, and evaluation of administrative and/or engineered controls.

Texas Regulations for Control of Radiation (TRCR)--All sections of Title 25, TAC, Chapter 289.

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Whole body--For purposes of external exposure, head, trunk including male gonads, arms above the elbow, or legs above the knee.

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