TEXAS WOMAN'S UNIVERSITY™

Radiation Safety Program

Radioactive Materials Procedures Manual

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TEXAS WOMAN'S UNIVERSITY™

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I. INTRODUCTION

The Radiation Safety Program at Texas Woman's University (TWU) exists to protect employees, students, and visitors, as well as the public and the environment, from the harmful effects of exposure to ionizing radiation. This manual describes the procedures TWU has implemented to ensure a safe campus environment. TWU is committed to meeting all applicable regulatory requirements and to keeping doses from licensed sources of radiation As Low As Reasonably Achievable (ALARA).

The Radiation Safety Officer (RSO) is responsible for managing the radiation safety program with support from the office of Environmental Health & Safety (EHS) and the Radiation Safety Committee. Laboratory protocols containing specific radiation safety related procedures and protocols for use by laboratory users will be developed by principal investigators and/or lab supervisors as necessary.

II. PURPOSE AND SCOPE

The purpose of this manual is to establish the requirements for the use of licensed radioactive materials at Texas Woman's University (TWU), in any physical or chemical form. The Radiation Safety Manual is dedicated to Radiation Producing Equipment.

TWU's special license, L00304, determines the restrictions on radioisotopes, quantity (radioactivity), location of work, and type of experiments authorized. The current version of TWU's Radioactive Material license is available through the RSO.

License Number

L00304

Issuing Agency

Texas Department of State Health Services (TDSHS), Bureau of Radiation Control (BRC)

III. ORGANIZATION AND RESPONSIBILITIES

A. Radiation Safety Committee (RSC)

The RSC advises the TWU administration on matters related to radiation safety and recommends policies and procedures it deems appropriate to ensure an adequate radiation safety program.

The RSC should be comprised of at least 5 members, consisting of one Licensee of each type of radiation producing equipment, one Licensee from each department utilizing radioactive materials (when appropriate), as well as:

- The Radiation Safety Officer.
- The Executive Director of Public Safety.
- The Director of Environmental Health & Safety.
- The Purchasing Agent.
- The Chairperson of the RSC (which can be one of the other members).

The RSC shall meet as often as necessary to conduct business, but no less than 3 times a year. A quorum shall consist of a simple majority of the committee, including the chairman and RSO. The RSC shall meet as often as needed to review:

- New or changing uses of radioactive materials;
- Changes in radiation safety staff and organizational structure;
- Changes in regulations;
- Radiation incidents and emergencies; and
- Procedural changes.

Specific responsibilities of the RSC include:

- Review and approve applications for possession and use of radioactive materials.
- Notify and advise the Provost and Vice President of any violation of federal or state regulations which might result in fines or penalties imposed on the University. Payment of fines or penalties will be the responsibility of the department whose non-compliance resulted in such action.
- Assist the RSO in reviewing or auditing radiation safety program operations as needed.

B. Radiation Safety Officer (RSO)

The duties of the RSO include:

- Direct the radiation safety program.
- Oversee the purchase, receipt, storage, use, survey, and disposal of radioactive or radiation-producing materials.
- Oversee the inventories of radioactive materials on campus.
- Ensure the most current legal requirements are identified and evaluated for compliance.

- Ensure TWU's radioactive materials license is maintained and kept up to date.
- Establish, coordinate, and adhere to the radiation safety procedures outlined in this manual and all applicable regulatory requirements from TDSHS.
- Inspect university facilities where radioactive materials are used for regulatory compliance and worker protection, or in response to a notice of a possible violation.
- Assist Licensees and Authorized Users with meeting radiation safety training requirements.
- Serve as the official university contact for federal and state regulatory agencies regarding radiation safety compliance and communicate compliance requirements to university officials.
- Conduct an annual assessment of the program and write an Annual Report of the relevant operations per Academic Year.
- Has the control and authority to institute corrective actions including shutdown of operations when necessary.

C. Environmental Health & Safety (EHS) and Risk Management

The duties of the Environmental Health & Safety and Risk Management departments include:

- Assist the RSO in maintaining the overall radiation safety program.
- Arrange for proper disposal of radioactive materials.
- Inspect for radiation safety compliance during routine inspections.

D. College Deans, Chairs, and Directors:

The duties of the college Deans, Chairs, and Directors include:

- Ensure the safe operations of all laboratories and other sites in the respective college or work area where radioactive materials are used.
- Ensure compliance with all applicable regulatory requirements, as well as the University policy and procedures described in this manual.
- Determine and assess fiscal responsibility in the departments resulting from fines and or damages stemming from non-compliance.
- Provide safety equipment and engineering controls as deemed necessary by the RSO;
- Have enforcement authority, with consultation through the RSO and/or RSC, to close a laboratory for safety or regulatory violations.

E. Licensees

The duties of Licensees, which includes Principal Investigators and Laboratory Supervisors in charge of licensed radioactive material usage, include:

- Comply with all license and registration requirements, regulations, programs, and procedures specified by the RSO/ EHS.
- Complete all required radiation safety training courses and ensure all required protective equipment, engineering controls, and safety precautions described in this manual and any applicable owner's manuals are used by all members of their area.
- Handle all radioactive sources and radioactive waste in accordance with this manual, TWU's Regulated Waste Procedure, and applicable regulations.
- Periodically inspect their laboratory or work area to ensure compliance with this manual and applicable regulations.
- Ensure inventories of radioactive materials are accurately maintained at all times and submitted quarterly to the RSO.
- Notify the RSO and EHS of all incidents involving radioactive materials. Report non-compliance issues or concerns to the RSO or Director of EHS.
- Have the primary responsibility for the health and safety of their faculty, staff, students, and visitors.
- Complete, and ensure all authorized users under their control complete, required radiation safety training courses, including annual refreshers.

F. Authorized Users

Authorized users shall:

- Comply with all license and registration requirements, regulations, programs, and procedures specified by the RSO/ EHS.
- Report any condition which, in the individual's opinion, is unsafe or improper.
- Complete all required radiation safety training courses prior to working with radioactive materials and annual refresher trainings.

IV. LICENSING AND REGULATORY REQUIREMENTS

TWU's Radioactive Material license includes specific conditions and regulations that apply to the use of radioactive materials covered. A copy of the current TWU Radioactive Material License and applicable state regulations are available upon request from the RSO.

Rules and procedures established for use within the University shall comply with the regulations and requirements of the Texas Department of State Health Services - Radiation Control Program detailed in the Texas Administrative Code 289, the Texas Health and Safety Code Ch. 401 (Texas Radiation Control Act), and Title 10 Parts 19,29, and 35 of the Code of Federal Regulations.

A. Authorization to Use Radioactive Materials

Any faculty or staff member at TWU who wishes to procure and use radioactive materials must obtain approval and be added to TWU's license prior to purchasing or using any radioactive material by submitting The Application to Use Radioactive Materials (Attachment D) to the RSO. The RSO will review the application with the RSC and, if approved, will submit the Faculty request to be added to the license as a Licensee.

The applicant must be in a position of authority over laboratory personnel and operations to obtain authorization. The RSO, RSC, or EHS may at any time place additional conditions or restrictions on a Licensee for reasons of safety and/or compliance with TDSHS. Only work which is authorized under the applicable License may be performed. The authorization may include restrictions or limits on:

- Radioisotope authorized for possession/use.
- Activity per radioisotope.
- Chemical or physical form of each the radioisotope.
- Location of use and/or storage of radioactive materials.
- Types of experiments authorized.

Radioactive materials shall not be used in or on humans without appropriate approval. Radioactive material usage in animals requires concurrent approval from the Institutional Animal Care and Use Committee (IACUC) and the RSC.

V. RADIATION EFFECTS, SAFETY PRACTICES, AND DOSE LIMITS

The effects of chronic low doses of radiation (in the range of 0 - 5 rem per year), as typically received by occupationally exposed persons, are not well known. Conversely, acute high doses of radiation (>100 rem in one exposure) are known to increase the risk of stochastic effects such as cancer in the exposed individual or genetic effects in the progeny of the individual. By extrapolating the dose-effect relationship from high doses to low doses using the linear non-threshold theory, increased risks for stochastic effects can be estimated even for very low radiation doses (Reference USNRC Regulatory Guide 8.29).

These data and models lead to the conclusion that there is no dose which is one hundred percent "safe", i.e., completely without risk. However, natural and man-made background radiation is ubiquitous, providing an average annual radiation dose of 0.360 rem to every U.S. citizen. Large fluctuations in background radiation, by geographical location, have not been shown to result in any measurable increase in risk of any health effect. Nevertheless, any radiation dose received occupationally will be in excess of the background radiation dose received and will be assumed to carry with it additive risk of deleterious effect.

State and federal regulations have established a system of dose limitation and minimization (see below for dose limits). Individual doses are limited to ensure that negative effects (such as cataracts) are avoided and that total lifetime risks of long-term effects (such as cancer and hereditary effects) do not exceed overall health risks for those persons working in safe industries. However, regulations also require that Authorized Users make every reasonable effort to maintain exposures to ionizing radiation as far below the dose limits as is practical with social, economic, and technological factors taken into account. This concept or philosophy is given the special name ALARA, which is an acronym for As Low As Reasonably Achievable.

To keep radiation exposure ALARA, the following practices should be followed when handling radioactive materials:

- Appropriate PPE shall be worn at all times, including *at a minimum*: gloves, lab coat, closed-toe shoes, and protective eyewear. Additional PPE should be used when necessary based on a risk assessment. For example, splash hazards would require the use of safety goggles.
- Protect your wrists. Lab coat cuffs may hang down and drag across contaminated surfaces. To protect the skin of your wrists, consider one of the following steps:
    - Wrap tape around your lab coat sleeve, or put a rubber band around the sleeve, to keep the cuff from dragging.
    - Wear long gloves and tuck your lab coat sleeves into the gloves.
    - Wear Tyvek sleeve protectors.
    - Survey the skin of your wrists frequently as you work.
- Avoid using petroleum-based hand creams when using gloves, because these types of creams may increase glove permeability.
- When liquid radioisotopes are handled, a survey should be performed of the area with a portable detection meter (e.g. Geiger-Müller counter) where appropriate for the respective isotope.

- Radiation and contamination monitoring of work areas is required during and after completion of each experiment.
- Radioactive material work surfaces must be covered with plastic-backed absorbent pads to prevent contamination.
- Volatile forms of radioactive material must be opened and used in an operating chemical fume hood. This includes I-125, I-131, and many forms of S-35.
- Minimize time exposed and increase distance from the source of radiation as much as possible.
- Use appropriate shielding for the radioisotope in use. For radioisotope-specific information on shielding, see guidance on specific radioisotopes (Attachment N).
- No food, drink, chewing gum, or applying cosmetics is allowed in the lab; pipetting by mouth is forbidden.
- Radioactive waste and contaminated material are to be appropriately disposed of as directed by the principal investigator and/or the RSO. Contaminated waste must be placed in designated containers.

  Users must comply with all other applicable rules and procedures of the TWU Chemical Hygiene Plan.

A. General Shielding Guidelines

Alpha (α) particles have very short ranges, and most can be stopped by a thin sheet of paper, so shielding of alpha radiation alone does not pose a difficult problem. Alpha radioisotopes can lead to serious health hazards when inhaled or ingested.

Beta (ß) particles are best shielded by materials of a low atomic number (e.g. plastic, plexiglass, glass) to prevent Bremsstrahlung radiation. Beta particles can be completely stopped in a shielding material. Polymethyl methacrylate (Plexiglass) or glass are appropriate shielding materials.

Gamma (γ) particles are far more penetrating than beta particles and cannot be completely stopped (shielding only reduces the dose received). They require dense shielding materials, such as lead.

B. Radiation Dose Limits

Occupational Dose Limits for Adults:

- Total Effective Dose Equivalent (TEDE) - 5 rem/y (5,000 mrem/y)
- Total Organ Dose Equivalent (TODE) - 50 rem/y (50,000 mrem/y)
- Shallow Dose Equivalent (SDE) -50 rem/y (50,000 mrem/y)

- Extremity Dose Equivalent -50 rem/y (50,000 mrem/y)
- Lens (of Eye) Dose Equivalent (LDE) - 15 rem/y (15,000 mrem/y)

Dose to an Embryo/Fetus of a Declared Pregnant Woman (occupational exposure)

- Total Effective Dose Equivalent (TEDE) - 500 mrem over entire pregnancy
- TEDE should not vary substantially above 50 mrem in any month

Individual Members of the Public

- 2 mrem in any one hour
- Total Effective Dose Equivalent (TEDE) - 0.1 rem/y (100 mrem/y)

Individuals who self-identify as pregnant may wish to complete a Declaration of Pregnancy Form (Attachment B).

C. Exposure Control

External exposure controls include the use of time, distance, and shielding to minimize radiation doses. All hazards from ionizing radiations should be minimized by using the lowest activity source or energy consistent with experimental requirements.

1. Internal Exposure

The only reasonable method by which internal exposures can be controlled or minimized is by preventing the intake of radioactive materials. The four routes by which radioactive materials can be taken into the body are:

- Inhalation
- Ingestion
- Absorption through the skin
- Injection through wounds

2. External Exposure

External exposure can arise from any source of penetrating radiation, e.g. gamma emitters, neutron sources and hard beta emitters. Sealed sources, used under normal conditions, should only present an external hazard, while open sources can present both hazards.

3. General Exposure Control Practices

- Cover the work surface with protective and absorbent bench paper to trap droplets of contamination.

- All volatile forms of radioactive material must be opened and used in an operating chemical fume hood suitable for volatile radioactive work. Iodine is a volatile radioisotope and iodinations must always be performed in a fume hood.
- If there is a possibility of radioactive materials becoming airborne (e.g. aerosols, dust, vapors, etc.) work should be performed in an absorbent-paper lined fume hood.
- When utilizing microcentrifuges:
    - Wipe down the exterior of the tubes before placing them in the microfuge.
    - Don't fill tubes more than 2/3 full.
    - Use tubes with locking caps or with screw caps (the type with O-rings).
    - Consider using an aerosol-tight rotor so that only the interior of the rotor becomes contaminated.
    - If working with radioisotopes in animals, please see Attachment L.

VI. EMPLOYEE DOSE MONITORING

Employee monitoring for radiation doses is done primarily by dosimetry badge monitoring and analysis. The purpose of radiation dosimetry is to measure the radiation dose equivalent received by occupationally exposed individuals at TWU. The results serve to verify and document compliance with the applicable dose limits (previously mentioned) as well as to identify problems and monitor the effectiveness of existing radiation safety controls. Texas regulations require employee dose monitoring when employees are likely to receive an annual dose in excess of 10% of the dose limits described in the radiation dose limits section above. Therefore, some users of radioactive materials may not be monitored individually for external radiation exposure (will not receive dosimetry "badges") because of the very low radiation exposure associated with their respective work. All users required to wear, or requesting a dosimetry badge, must complete the Dosimeter Request Form in Attachment N. Employee dose monitoring includes prior occupational cumulative lifetime dose information, which will be utilized to track current and cumulative dose exposures, in accordance with RC Form 202-2, and RC Form 202-3. However, it should be noted that dosimeters are generally **incapable** of monitoring doses from low energy beta emitters such as H-3, C-14, and S-35. Therefore, bioassays may be required after spills, contamination incidents, or where the RSO deems appropriate for dose monitoring in an individual likely to receive >10% of the annual limit on intake (ALI). Currently, no isotope usage, including H-3, are used in quantities anywhere close to exceeding 10% of the ALI. However, use of I-125 and I-131 in excess of quantities described below will require participation in the iodine bioassay program, should they occur.

A. Personal Radiation Dosimetry

Radiation dosimeters appropriate for the potential exposure will be issued and monitored by the RSO to the individual and shall be worn by TWU employees likely to receive, in one year, a dose in excess of 10% of the applicable dose limits.

The RSO and RSC shall determine the "likely to exceed 10%" status of an individual and the dosimeter type.

Wear periods are 3 months in duration. Each employee required to wear a personal dosimeter badge will receive a new monitoring badge from the RSO (or representative) every 3 months. Radiation dosimeters shall not be deceptively exposed.

1. General Dosimeter Guidelines

- Dosimeters are issued to only one person. Dosimeters shall not be shared.
- Dosimeters in storage and not being worn shall not be stored near sources of radiation.
- Dosimeters should not be exposed to high heat, chemical or physical damage, or washed in a washing machine.
- No person shall wear dosimeters issued by TWU while working for another employer or institution.
- Authorized Users shall notify the RSO if they are concurrently working for another (non-TWU) employer with sources of ionizing radiation or radioactive materials.
- Dosimeters shall not be worn during personal medical or dental x-ray examinations.
- Dosimeters shall not be worn after medical administration of radioactive materials (e.g. thyroid ablation therapy, cardiac stress tests, diagnostic nuclear medicine tests, etc.).
- Licensees shall notify the RSO immediately upon learning of possible deceptive exposures of dosimeters.
- Intentional deceptive exposures of dosimeters are forbidden and may result in enforcement actions.
- Lost or damaged dosimeters shall be reported to the RSO as soon as possible.

2. Proper Dosimeter Use

Whole body dosimeters are the most common type of monitoring device worn by persons working with radioactive materials and measure the dose received by a person's whole body. Whole body dosimeters shall be worn at the location on the body likely to receive the highest dose (refer to definition of "whole body" in Definitions).

Ring dosimeters provide a measurement of the extremity radiation dose equivalent received by the lower arm and hand. If required to use this in consultation with the RSO, it should be worn under a protective glove on a finger of the hand likely to receive the highest dose.

Declared pregnant women, who wear dosimeters for fetal monitoring, shall wear the dosimeters on the abdomen.

Licensees or their designees shall collect and return used dosimeters to the RSO promptly after receiving replacement dosimeters at the beginning of a new wear period.

Any person who works with any source of radiation at TWU (or did so in the past) may request a copy of their dose records at any time. These records are maintained by the RSO and are available from them upon request.

B. IODINE BIOASSAY

Since radio-iodinated solutions and compounds undergo decomposition which can result in volatilization of radioiodine, individuals working with these materials have the potential for accidental update of radioactive iodine. The bioassay measurements are used to confirm the adequacy of radiological controls and to determine compliance with occupational dose limits.

TABLE 1 – ACTIVITY LEVELS ABOVE WHICH BIOASSAY FOR I-125 OR I-131 IS REQUIRED

TYPE OF OPERATION	ACTIVITY HANDLED IN USEALED FORM	
	Volatile or Dispersible	Bound to Non-Volatile Agent
Process in open room or bench with possible escape of iodine from process vessels	0.1 mCi	1.0 mCi
Process with possible escape of iodine carried out within a fume hood of adequate design, face velocity and performance reliability	1.0 mCi	10 mCi
Processes carried out with gloveboxes, ordinarily closed, but with possible release of iodine from process and occasional exposure to contaminated box and box leakage	10 mCi	100 mCi

Individuals who handle unsealed quantities of I-125 and I-131 in excess of the quantities listed in Table 1 above must participate in the iodine bioassay program. The quantities in Table 1 apply to the amount handled either in a single usage or the total amount handled over a period of three consecutive months. It is the responsibility of the Licensee to notify the RSO of all individual authorized users working under their authorization who require bioassay for radioiodine prior to commencing work.

The general program, including iodine bioassay types (baseline, emergency, separation, etc.), frequencies, and action levels will be generally conducted in accordance with USNRC Regulatory Guide 8.20. The only exception to this is that the activity levels for which bioassays will be required will be pursuant to Table 1 of this document as they are more conservative than the regulatory guide.

VII. RADIATION SURVEYS

Surveys are used to identify and quantify radiological hazards and to document regulatory compliance. These surveys are conducted either by direct monitoring of the area using a survey meter or doing wipe tests that are analyzed using a scintillation counter. All surveys should subtract background radiation from observed levels to get a net rate. When radioactive material is handled in the form of solutions or powders, both radiation surveys and contamination surveys should be performed to prevent unnecessary radiation exposure to personnel and to prevent the spread of contamination throughout the facility. Documented surveys must be performed using the radiation survey form (Attachment F) at least monthly in all areas where radioactive materials are stored or used. The RSO will perform sealed source leak test surveys at six-month intervals documented on the sealed source leak test survey form (Attachment G), and area and contamination surveys of waste storage areas at one-month intervals documented on Attachment F.

A. Radiation Survey Types

Radiation surveys are performed to measure exposure or dose rates from sources of radiation which are in storage, in waste, or in use, typically using a calibrated portable survey meter (e.g. Geiger-Müller counter). Radiation surveys shall be performed at least monthly and documented. Records of surveys should be maintained by the Licensee and a copy provided to the RSO.

Contamination surveys are used to determine levels of radioactive contamination on surfaces in the laboratory or on personnel. Contamination surveys may involve the use of a portable instrument or the use of wipes which can subsequently be counted using a suitable radiation detector (e.g. scintillation counter). Contamination surveys shall be performed as necessary during experimental

processes, and after each experimental process using unsealed radioactive materials, but at least monthly and are necessary to demonstrate compliance with the regulations. Contamination surveys shall be performed and documented on the radiation survey form (Attachment F). Records of surveys should be maintained by the Licensee and a copy provided to the RSO.

Leak test surveys are used to detect leakage of radioactivity from sealed sources containing 100 microcurie (3.7 MBq) or more of beta or gamma emitting material or 10 microcurie (370 kBq) or more of alpha or neutron-emitting material. Leak tests should be conducted using wipe tests analyzed with a suitable scintillation counter capable of detecting the presence of 0.005 microcuries. Leak test surveys shall be performed at intervals not to exceed 6 months for all sources, except alpha emitters which shall not exceed 3 months. Leak tests shall be performed any other time there is reason to suspect damage or leakage from the sealed source. Leak test surveys shall be performed and documented on the sealed source leak test form.

B. Specific Radioisotope Rules

Laboratories in which only H-3 is used need only perform properly documented wipe tests. All other laboratories must perform both meter surveys and wipe tests each month.

Records of Surveys must include:

- Date of the survey.
- Name of the surveyor.
- Map/sketch.
- Survey meter make, model, serial number and calibration date.
- The background radiation level observed.
- The results of the wipe test, meter survey, or both (i.e. no contamination found, all readings < background etc.).

C. Radiation Detection Equipment

Each Licensee must possess radiation detection equipment that is appropriate for detecting the types of radiations emitted by the radioisotopes for which they are authorized.

For authorization to possess any quantity of H-3 (tritium) or quantities of C-14 of 250 µCi or less, Licensees must possess or have access to a liquid scintillation counter. Portable radiation detectors are not useable for detection of H-3 unless specifically designed as a tritium contamination detector.

For authorization to possess any other beta emitting radioisotope, for C-14 in quantities exceeding 250 µCi, and for any gamma emitting radioisotope, the Licensee must possess a properly operating portable radiation detector appropriate for detecting those radiations.

- A thin window Geiger-Müller counter is normally the best choice for most alpha and beta emitting radioisotopes.
- A portable scintillation detector is required for Licensees authorized to possess I-125 in activities greater than 1 mCi.

Portable radiation detectors shall be calibrated, or response checked, as appropriate for the use of the instrument, at least annually or after repair of the instrument. Battery replacement is not a cause for performing a calibration. Calibrations must be performed by an approved 3rd party vendor. Contact the RSO for assistance with calibration requirements.

For additional information on radioisotopes and their respective detection equipment, see guidance on specific radioisotopes (Attachment M).

D. Frequency of Surveys

Survey frequency depends upon the amount, type, and frequency of radioactive material used. Listed below are examples that may be useful in determining how often to perform surveys. The greater the workload, the more often the surveys should be performed. It is recommended that whenever working with radioisotopes users conduct frequent surveys of hands and other skin areas to identify and rectify contamination, thus preventing significant doses and internal exposures.

Surveys are to be conducted:

- After each day of radioactive material usage/experimentation;
- After transfer of radioactive material from stock solutions;
- After each experimental run if there is a possibility of a change in radiation levels or contamination;
- After any radioactive spill cleanup (no matter how minor) or emergency; and
- At least once a month where radioactive materials are stored, even if not actively used.

E. Methods of Surveys

Suggested methods for performing surveys are given below. Records of these surveys should be maintained for inspection and for reference to determine whether the radiation levels or the contamination levels remain constant or increase over a period of time.

1. Radiation Level Surveys

A portable survey instrument with the greatest sensitivity capable of measuring levels as low as 0.1 mrem/h should be used and the results recorded on the radiation survey form (Attachment F). A sketch of the area should be used to make an easily prepared and easily understood survey record when annotated with this information.

2. Contamination Level Surveys

A series of wipes using filter papers or other suitable material should be taken from surfaces where contamination is expected. (e.g., where solutions are prepared or pipetting is performed). The wipes should be numbered and their location indicated on a sketch as described above. The wipes should be rubbed over an area of approximately 100 cm2 to maintain a consistent means of determining the amount of removable contamination. The wipes may be counted using a gamma scintillation well counter, a liquid scintillation counter, or thin crystal scintillation probe with scaler, or any detector capable of detecting a small amount of contamination on the sample. Contamination level surveys shall indicate no detectable contamination above background. If detectible contamination (above background) remains after decontamination efforts, contact the RSO for assistance.

Locations to check for contamination:

- Door handle to the laboratory on refrigerator/freezer;
- Bench tops and desks where contamination should not be found;
- Floors adjacent to benches where material is used;
- Fume hood sill;
- Potentially contaminated equipment;
- Liquid scintillation counter or gamma counter; and
- Any item or location in the laboratory that should not be contaminated.

VIII. POSTINGS AND LABELING

The following posting and labeling procedures are required:

- **"Caution (or Danger) Radioactive Material(s)"** signs shall be conspicuously posted on all doors or entrances to rooms or areas in which licensed radioactive materials are used or stored.
- Similarly, **"Caution (or Danger) Radioactive Material"** labels shall be placed on radioactive materials containers holding radioactive materials in quantities (activities) greater than those specified in 25 TAC §289.202(ggg)(3) unless:

  - The containers are attended by an individual who takes the precautions necessary to prevent the exposure of individuals in excess of the applicable dose limits, or
  - Containers that are in transport and properly labeled for such.
  - Individual containers which are too small for **"Caution (or Danger) Radioactive Material"** labels shall instead label the outside of the equipment, outer container, or area, respectively.
- Signs and postings shall display the trefoil symbol and be red, orange, or yellow in contrast to the surrounding environment.
- Each refrigerator and freezer where radioactive material is stored must have a **"Caution Radioactive Material"** sign and a **"Store No Edibles,"** or equivalent sign visibly displayed.
- Radiation labels must be affixed to all items associated with the use of radioactive material.
- Signs and postings should be removed when conditions no longer warrant that posting.
- A **Notice to Employees**, RC Form 203-1 for all areas with Radiation Producing Equipment or Radioactive Materials must be posted conspicuously. The current form can be obtained from the RSO or the TDSHS website.

IX. TRAINING

All individuals who work with or (in some cases) near radioactive materials are required to complete basic radiation safety training conducted or approved by the RSO and/or the RSC, and area/task specific radiation safety training conducted by the respective Licensee. The depth of the training must be commensurate with the level of hazard to which the individual is exposed. All training must be documented via the training record and acknowledgement form (Attachment K). No individual shall be allowed to work with sources of radiation until that person completes appropriate radiation safety training.

A. Basic Radiation Safety Training

All Licensees and Authorized Users who work with or are authorized to possess radioactive materials, are required to complete appropriate radiation safety training course(s) offered or approved by the RSO prior to working with radioactive materials for the first time and annually thereafter.

Training subject matter shall include but is not limited to: fundamentals of radiation safety, pertinent Federal and State regulations, radiation detection instruments to be used, equipment to be used, and TWU specific procedures and recordkeeping requirements.

B. Area/Task-Specific Radiation Safety Training

Each Licensee is responsible for providing and documenting laboratory-specific training to individuals (including students) who work with radioactive materials under their control. This training shall address, as applicable:

- Area restrictions - where radioactive materials are used within the lab(s) and restrictions on that use;
- Procedures for security;
- Posting locations for required signs and notices; and
- Hands-on review of protocols, safety measures, personal protective equipment, and special handling techniques involving radioactive materials.

C. Individual Training

Training for individuals who work in areas radioactive materials are used or stored (but don't use the materials themselves) shall include:

- A brief discussion of hazards of radiation and radioactive materials;
- Recognition of warning signs;
- Security measures;
- Areas and materials from which such persons are restricted; and
- Person(s) to contact in the event of incident or emergency.

Ancillary personnel, such as those in Shipping/Receiving in the Facilities Management Warehouse and TWU Department of Public Safety officers, may require radiation safety training under certain conditions. The RSO provides customized training for these individuals.

X. COMMISSIONING/DECOMMISSIONING LAB SPACES FOR RADIOACTIVE MATERIALS USE

A. Commissioning of Lab Spaces for Use of Radioactive Material

Upon approval of an application to use radioactive materials (Attachment D) by the RSC, the RSO will visit the lab to determine what is necessary to commission the lab. This typically includes, but is not limited to:

- What signs and postings are needed;
- The type of survey instruments needed;
- The areas where radioactive materials will be used;
- Explaining the types of radiation surveys that must be performed;

- Determining the recommended frequency of radiation surveys;
- Explaining the proper method of maintaining material inventory;
- Reviewing the need for and methods of proper material storage and security; and
- Additional relevant information as it pertains to the specific radioisotopes and activities.

B. Lab Changes

After the initial set-up and approval, the Licensee must have RSO approval before moving radioactive material to any rooms not initially authorized. The Authorized User may NOT move radioactive materials or radioactive material contaminated items into a room before this is approved. All locations must be added to the TWU Radioactive Material License via license amendments prior to this approval.

C. Decommissioning of Lab Spaces Which Utilized Radioactive Material

If needing to relocate radioactive materials in the event of lab decommissioning, please notify the RSO as soon as possible. Remember, all locations must be added to the TWU Radioactive Material License via license amendments prior to this approval. Do NOT relocate radioactive material to a new location until this approval has been granted.

- All radioactive waste must be scheduled for pickup by the RSO.
- Any radioactive material that is to be transferred to another Licensee must be scheduled for pickup by the RSO.
- The Licensee must decontaminate all areas which have contamination, then perform final radiation and contamination surveys of the lab.
- The Licensee should perform a final visual inspection of lab spaces to ensure no radioactive stock vials, samples, wastes, etc. remain in the lab.
- Once the Licensee notifies the RSO that the lab is empty and ready for final inspection, the RSO will perform a visual inspection, radiation surveys, and contamination surveys of the lab. If wipe tests show residual radioactivity, lab staff will be required to decontaminate and a second wipe test will be performed.
- Upon completion of decommissioning, the RSO will submit the necessary documentation to remove the respective area from the license.

XI. PROCUREMENT, INVENTORY AND TRANSFER OF RADIOACTIVE MATERIALS

The receipt, use, storage, and disposal of radioactive materials must be tracked from initial receipt at TWU to final disposal. Accurate inventories and thorough documentation are fundamental controls necessary for TWU to demonstrate compliance with State and Federal regulations.

A. Procurement of Radioisotopes

Each Licensee is responsible for ensuring proper procurement procedures are followed, even if a centralized procurement process is used by the department. The radioisotope purchase requisition form (Attachment E) must be used and submitted to the RSO for all purchases. The following procedures should be followed when ordering radioactive materials:

- Prior to ordering radioisotopes, the Licensee shall obtain RSO/ RSC approval to place the order.
- Radioactive materials may not be purchased using a TWU P-Card.
- Radioactive materials may be delivered only to destinations approved by the RSO and listed on the active Radioactive Materials License.

B. Receipt of Radioactive Shipments

In this section, the term "shipment", applies to receipt of any licensed radioactive material whether they are purchased from a commercial vendor, loaned by a colleague from another institution, or otherwise brought onto the TWU Denton campus.

Radioactive materials shall be delivered directly to the RSO or to the Authorized User in their respective laboratory where they will be used, not to departmental offices.

Deliveries shall only be made during normal business hours when an Authorized User or the RSO is available to receive the shipment.

All incoming shipments of licensed radioactive materials must be received, inspected for damage, surveyed with a portable radiation detector or wipe tests, as applicable, and documented on the radioactive materials inventory & usage sheet (Attachment H) within three hours of receipt. Upon receipt, the external surfaces of the package must be monitored for radiation levels using a Geiger counter and for radioactive contamination using a wipe test as follows:

- External radiation levels should be measured around all surfaces of the exterior of the package. If the level is greater than 200 mrem/hr at the surface of the package, immediately notify the RSO.

- Wipe tests should be done by swiping over an average area of 300 cm^2. Sufficient measurements must be taken in the most appropriate locations to yield a representative assessment of the removable contamination levels.
- If the wipe test results indicate no or minimal contamination is present on the outside of the package (less than 22 dpm/cm^2), the package should be processed as usual.
- If the wipe test results indicate that removable contamination levels are between 22 dpm/cm^2 and 220 dpm/cm^2, the package should be decontaminated prior to further handling, and the RSO notified.
- If the wipe test results indicate that removable contamination levels are greater than 220 dpm/cm^2, the package should be placed in a posted contaminated area and the RSO immediately notified.

If either the external radiation or removable contamination levels exceed the limits above, the RSO should be immediately notified. The RSO will then immediately notify both the package carrier and TDSHS when levels in excess of 25 TAC 289.202(ee)(4)(A)(ii) are found.

C. Inventory of Radioactive Materials and Sealed Sources

Each Authorized User shall maintain accurate inventory records using the radioactive materials inventory & usage sheet (Attachment H) to track their usage at all times and submit their inventory monthly to the RSO.

Inventories shall include:

- Receipt date;
- Amount received (activity);
- Use date, quantity used (activity), and balance remaining; and
- The amount disposed should always be added to the correct waste container log.

The RSO will periodically review associated inventory records of Licensees (previous inventories, purchase records, waste logs, etc.) to ensure on-hand inventories and records are accurate.

Discrepancies between expected inventories based on RSO records and/or the Licensee's inventory and the actual materials on-hand shall be noted, explained in writing with supporting documentation by the Licensee, and returned to the RSO with the current inventory records.

The RSO will maintain accurate inventories of all radioactive materials under their control including waste transferred to them for decay in storage, and waste stored prior to off-site disposal.

D. Transfer of Radioactive Materials

"Transfer" of a radioactive material, as used in this section, does not include transfer of radioactive materials to the RSO/ EHS for disposal. "Transfer" refers to a change in custody or control of a radioactive material even if there is no change in ownership. An example would be a transfer of C-14 from one Licensee (department or laboratory location) at TWU to another.

Transfers require prior RSO approval. Transfers must be documented and the materials inventory should be updated for each lab or work area involved in the transfer.

XII. RADIOACTIVE WASTE DISPOSAL

A. General Requirements for Disposal of Radioactive Materials

No Authorized User may dispose of radioactive materials except:

- By transfer to the RSO for off-site disposal/decay in storage; OR
- As specifically authorized by the RSO and RSC.

Radioactive waste must be segregated by radioisotope/half-life and state (solid, or liquid).

All radioactive waste containers (carboys, bags, trash cans, etc.) shall be conspicuously marked with the trefoil symbol and the words "Radioactive Waste" as well as the specific materials which make up the waste.

Radioactive waste held for off-site disposal shall be kept in a closed, rigid container to prevent leakage, be kept in a secure area, and be shielded as appropriate.

Document all disposal on a waste container log (Attachment I). Contact the RSO to coordinate waste pickup. The RSO, in conjunction with EHS, will ensure radioactive waste is sent through approved/permitted transporters and disposal facilities. Disposal documentation must be maintained on-file for 3 years after final disposal.

Licensees and/or the RSO shall not hold radioactive waste **not** authorized for disposal by decay in storage for longer than **24 months** unless prior authorization is obtained by TDSHS.

B. Liquid Waste

Radioactive materials are not allowed to be disposed via the sanitary sewer per City of Denton ordinance.

Survey wash water before declaring it non-radioactive and pouring it down the drain (two rinses may not be sufficient to remove all contamination). This procedure will ensure virtually no radioactive material is being released to the sanitary sewer system.

Liquid waste includes primary radioactive liquid and at least the secondary rinse. Place liquid wastes in a leak-proof container. Record the waste on the waste container log (Attachment I). Ensure that liquid radioactive wastes are not unnecessarily mixed with hazardous/regulated chemical waste.

C. Dry/Solid Waste

Place only dry, non-decomposable wastes such as gloves, paper, and glassware in Dry Waste Boxes. Do not put any liquids, capped vials, sharps, animals, bedding, or scat into the container.

Lead is NOT allowed to be placed in the Waste Boxes (this is a hazardous material).

Waste that emits more than 2mrem/hr at 30 cm must be shielded. Do not shield individual items in the box; shield the entire container. Bag waste contaminated with volatile materials, especially iodine, prior to disposal.

D. Hazardous/Regulated Mixed Radioactive Waste

This type of waste includes scintillation vials containing organic solvents with radioactive materials and bulk liquid radioactive waste containing hazardous chemicals (e.g. methanol, chlorinated solvents, etc.).

Do not mix hazardous chemicals with your radioactive waste unless it is necessary for your procedure. Mixing two separate hazard classes makes disposal more difficult and costly. Please consult EHS before mixing these chemicals with radioactive material.

Chemically toxic and/or hazardous waste mixed with radioactive waste will be handled on a case by case basis by prior arrangement with the RSO/ EHS. However, TWU's Regulated Waste Procedure should be followed as well.

E. Sharps

Discard sharps, such as pipettes, syringes and needles, broken glass, and razor and scalpel blades, into appropriate sharps containers bearing the radiation warning label. Use separate containers for different radioisotopes.

The full, closed, rigid sharps container may be placed in a dry waste box containing the same radioisotope. Enter the contents of the sharps container into the waste container log (Attachment I).

F. Biological Radioactive Waste

Radioactive biological waste disposal procedures will be handled on a case by case basis by prior arrangement with the RSO/EHS.

If radioactive material is administered in vivo; the animal itself, the cage it is housed in, the excrement, and bedding should be considered and handled as radioactive waste.

All biological radioactive waste (animal carcasses, tissue samples, etc.) must be properly bagged so that no liquid will leak out. Waste material contained inside must be prepared so that it cannot pierce the bag. This may entail padding parts of the biological waste with gauze pads or other material to keep the plastic bags from being torn and punctured.

1. Proper Bagging

Radioactive biological material should be placed in double plastic bags, making sure the material will not puncture or tear the bag.

The bag is to be sealed with masking tape as described below, after squeezing all air from bag.

- Twist top of inner bag into short "rope." Wrap tape around tightly two or three times.
- Bend top portion of twisted bag down along the taped section and wrap the tape two or three more turns. Bag is now sealed.
- The outer bag should be sealed in the same manner as above. If more than two bags are necessary to insure against leakage or puncture, each additional bag should also be sealed in the same manner.

2. Proper Labeling

Attach a tag on the disposal bag with this information:

- Department Name;
- Your Name;
- Identity and amount of the radioisotope; and
- Date.

3. Proper Disposal

Carcasses should be placed in a properly labeled bag in a freezer (which is designated for radioactive materials and appropriately labeled) until picked up by a vendor licensed for such disposal.

Carcasses and excreta can utilize decay-in-storage practices in a designated freezer.

G. Decay in Storage

The RSO will hold radioactive material with a half-life of less than or equal to 120 days for decay-in-storage. Radioisotopes must decay for 10 half-lives before removal.

After 10 half-lives have passed, but prior to disposal:

- Check at the surface of the waste for any activity above background with a calibrated survey meter.
- If the radioactivity cannot be distinguished from background radiation, remove/obliterate all radiation labels and transfer the waste into the appropriate waste stream (biological, chemical, non-hazardous, sanitary sewer). Consult EHS if necessary.
- Fill out the decay-in-storage log (Attachment J), entering disposal date, survey results, background radiation, instrumentation used, and your name.
- The waste container logs and decay in storage logs records must be kept for at least three years or until the next off-site disposal event.
- Decay in storage should only occur in a secure, adequately shielded area (if necessary), under control of the RSO.

XIII. TRANSPORTATION

Radioactive materials shall be packaged and transported in accordance with all applicable rules and regulations specified by the U.S. Department of Transportation (DOT), the U.S. Nuclear Regulatory Commission (NRC), the Texas Department of State Health Services (TDSHS), and International Civil Aviation Organization (ICAO) Technical Instructions. For the purposes of this manual, "transport" shall refer to the movement of radioactive materials in commerce or transportation to further a commercial enterprise in any vehicle on public roadways (including campus streets) or by air, water, or rail.

Radioactive materials handled by TWU employees, in TWU vehicles, for TWU purposes not associated with furthering a commercial enterprise is not considered "transport" for regulatory purposes. However, the following requirements still apply in this situation:

- Applicable training from the RSO must be taken and documented.
- Materials should be adequately secured/escorted to prevent theft or loss.
- Materials should be adequately secured to minimize potential for breakage in the event of an accident.

- Personal vehicles shall NOT be used to transport radioactive materials.

Requirements for packaging, transporting, or receiving radioactive materials related to regulated "transport":

- Any person who packages, transports, or receives radioactive material shipments and any person who prepares hazardous material transport documents or signs for the same, shall be trained according to Department of Transportation (DOT) regulations and certified to do so by the RSO or EHS.
- Persons who are not properly trained and certified shall not be allowed to package, transport, or ship radioactive materials. Contact the RSO for assistance.
- At no time shall any Licensee or Authorized User carry radioactive material aboard a passenger-carrying aircraft or in their personal vehicle.

XIV. RADIOACTIVE MATERIAL SECURITY

Licensees and Authorized Users are responsible for securing radioactive materials and sources from unauthorized removal or access at all times. The following are generally acceptable practices. If other security measures are employed, Licensees should consult with the RSO.

- If radioactive materials are accessible (unsecured) in a laboratory and no one is present in the laboratory, lock the laboratory doors to prevent unauthorized access; OR
- During periods when the laboratory is not locked, security may be maintained by direct surveillance. The person watching the lab or area shall be instructed to question unauthorized and/or unrecognized persons who enter the laboratory; OR
- If adequate security cannot be ensured when the laboratory is locked, the Licensee shall ensure that all radioactive materials are locked in a cabinet, drawer, refrigerator, freezer, etc. during periods when there is no direct surveillance by trained personnel.

XV. INSPECTIONS

Licensees may be inspected at any time by the RSO, EHS staff or TDSHS. The following information is intended to make the Licensee aware of the inspection program and to provide general information on what is expected of the Licensee.

A. Inspections by TDSHS

Inspections conducted by TDSHS may include spot inspections of individual Licensees. Such inspections are typically scheduled with one to two weeks prior notice.

All required documents and the Licensee should be present during the inspection.

B. Inspections by the RSO or EHS staff

Periodic inspections of areas storing or using radioactive materials are necessary to ensure safe working conditions and compliance with applicable rules, regulations and procedures. Inspections may include, but are not limited to:

- Records review;
- Radiation survey review;
- Inventory records;
- Waste records;
- Lab-specific procedures;
- Training documentation;
- Laboratory Tour;
- State of Texas required postings;
- "Caution – Radioactive Material" signs and labels, where appropriate;
- Radiation use areas match those on the license;
- Proper equipment in place and functional, as applicable (shielding, survey meter, scintillation counter, dosimeter badges, etc.);
- Waste handling procedures;
- Adequate security for radioactive materials;
- Contamination/Radiation Survey; and
- Performance of a wipe test of the laboratory.

The RSO and EHS staff reserve the right to inspect any Licensee with no notice. Generally, however, all routine inspections will be announced and scheduled at a time that is mutually acceptable with the Licensee.

Inspection reports by EHS will be generated in BioRAFT, where corrective actions and responses should be completed by the Licensee.

XVI. INCIDENTS AND EMERGENCIES

Any accident, injury, or loss of control of a radioactive materials that could cause an excessive or uncontrolled radiation exposure to any individual is referred to as a radiation emergency. The proper response to any radiation emergency depends upon a thorough understanding of the radioactive

materials involved and the magnitude of associated risks. Each user of radioactive material sources should be familiar with the basic emergency responses listed below and methods for applying them in their work area. Specific procedures for each respective area with radioactive materials should be given by the Licensee of the area in addition to these basic procedures.

All contamination events (personnel, materials, or environmental) should be appropriately surveyed, addressed, and documented. Appropriate notifications to TDSHS should be made pursuant to Title 25 TAC 289.202(xx), 289.202(yy), and 289.252(r).

If a serious or life-threatening emergency exists, contact the TWU Department of Public Safety (940-898-2911) or 911. In the event of other emergencies, spills, or accidents involving radiation not requiring immediate first responder response, contact the TWU RSO/EHS Director (940-898-3129).

A. Emergency Contact Information

TWU EHS 24-Hour Emergency Number	**940-268-3473**
TWU RSO/EHS Director (Drew Townsend)	**940-898-3129**
Ambulance/Fire Department	**911** *(Dial "9" first if using a university phone)*
TWU Department of Public Safety	**940-898-2911** Denton **214-689-6666** Dallas **713-794-2222** Houston
TDSHS 24-Hour Radiological Emergency Reporting *Used for reporting emergencies only.*	**512-458-7460**

B. What Constitutes an Incident or Emergency

- Loss or theft of any radioactive material.
- High or potentially high radiation exposure to an individual or to a member of the public.
- Intake or potential intake of radioactive materials by inhalation, ingestion, absorption through skin, or injection through skin or wound.
- Deceptive or potentially deceptive exposure of a dosimeter.
- Personnel contamination that cannot be completely removed after two washes with only soap and water.
- Spills involving any quantity of alpha emitting radioisotope, more than 1 microcurie of iodine-125 or iodine-131, or spills involving more than 10 microcuries of any other radioisotope.

- Any spill which is not or cannot be completely decontaminated before the end of that work day.
- Identification of any contamination which is outside of the restricted area, such as spills tracked or otherwise spread into offices, hallways, vehicles, etc.
- Accidental releases of radioactive material to the environment.
- Fires or floods which threaten to release radioactive materials to the environment or which threaten to expose emergency response personnel.
- Any transportation accident, whether on-campus or off-campus, involving radioactive materials.
- Any personnel injuries which may involve radioactive contamination or radiation exposure.

If you are unsure if your incident constitutes an emergency, please contact the RSO or EHS immediately for guidance.

C. Injuries Involving Contamination or Exposure to Radiation

- Provide first aid immediately for serious injuries if properly trained and it is safe to do so.
- Call 9-911 from a university phone or 911 from a personal phone.
- Notify the RSO/EHS.
- If possible, without doing harm to the victim, monitor the injured individual and remove contaminated clothing and gross personal contamination.
- Submit an incident report to EHS and/or a Worker's Compensation Packet through Human Resources, as applicable.

D. Decontamination of Personnel

Always don proper personnel protective equipment prior to beginning decontamination procedures. Gloves, safety glasses, lab coat, and closed toed shoes are <u>required at a minimum</u>.

- Remove and bag all contaminated clothing. Either hold contaminated clothing for decay if the half-life is short or treat as solid radioactive waste.
- Skin contamination should be cleaned using mild soap and water. Pay particular attention to the hands and fingernails. Use a portable survey meter to monitor for remaining contamination. If not free of contamination, rewash and resurvey.
- Keep cuts and abrasions covered when washing to prevent entry of radioactive material into open wounds.

- Gently wash with warm (not hot) water and lots of liquid soap. Do not scald, scrub or scratch your skin. Do NOT use hot water and coarse brushes as these can increase absorption. Even if contamination persists, stop before the skin becomes reddened and irritated.
- Do NOT use organic solvents, as these may increase the probability of radioactive material penetrating the skin.
- Hair contamination should be cleaned with up to three washings with liquid soap and rinse water; use appropriate gloves. Use towels to keep water from running into face and shoulders and contain the contamination as much as possible. Do not use conditioner as it will cause radioactive material to stick to your hair.
- Gently blow your nose; wipe your eyelashes, eyelids and ears with a clean, moist cloth.
- Keep all contaminated articles (towels, cloth, etc.) bagged for disposal.
- Call the RSO/EHS to report the incident even if the decontamination was successful.
- Survey for contamination elsewhere on the body as well as on clothes, shoes, floor, door handles, phone, etc. Document the surveys.
- If the contamination is in a wound (e.g., a cut from contaminated glassware), eyes, nose, or mouth, rinse with copious quantities of water.
- Seek medical attention if radioactive material was ingested, entered eyes/nose/mouth, or as necessary.
- **ALWAYS** contact the RSO for advice and final monitoring.

E. Radioactive Spills or Releases

Decontamination shall only be undertaken by properly trained individuals with the necessary protective gear, equipment, and or knowledge to do so safely. For major spills that cause a high radiation hazard (> 1 millicurie), vacate the room immediately, close all doors, keep everyone out and notify DPS, the RSO, and/or EHS. For large spills (i.e., greater than 10 microcuries) or spills that are difficult to clean up, the work should be carried out under the supervision of the RSO or EHS.

Typical steps to respond to non-major spill incidents are:

- Stop work and confine the spill immediately using an absorbent, enclosure, etc.;
- Warn others of the hazard and isolate the area;
- Notify the RSO/EHS;
- Absorb/sweep up spilled materials;
- Monitor personnel during and after cleanup for contamination;

- Collect all used cleanup materials as radioactive waste. Remove and bag all contaminated clothing or cleanable items for removal by the RSO or EHS;
- Commence wipe surveys and decontamination. Ensure surveys of surrounding areas are performed so that all contaminated areas are identified and decontaminated;
- Submit an incident report to EHS.

XVII. RECORDKEEPING

All Licensees of radioactive materials shall maintain the following records in a clear, concise, and orderly format and forward copies of all records to the RSO.

- Inventory records;
- Survey records;
- Lab/procedure-specific operating and emergency procedures;
- Training records for authorized users in their lab.

In addition to maintaining duplicates of all records mentioned above, the RSO shall maintain the following records which are available for review during normal office hours:

- Original license copy;
- Copies of current applicable regulations;
- Inventory records;
- Inspection reports and copies of all "Notices of Violation" issued by state or federal regulatory agencies and the TWU responses to those Notices;
- Current version of all applicable procedure manuals;
- Dosimetry records include the following:
    - Doses received to an embryo/fetus with the records of dose to the declared pregnant woman;
    - Lifetime cumulative occupational dose records (in accordance with RC Form 202-2);
    - Dose records for individuals who received exposures in accidental and emergency conditions (in accordance with RC Form 202-3);
    - Dose records kept for the current year shall be kept in accordance with RC Form 202-3
- Leak test results;
- Radiation survey and contamination survey records for all licensed areas; and
- Survey instrument calibration records.

A. Sabbaticals and Absences (28 calendar days or greater)

Licensees shall notify the RSO at least 30 calendar days prior to the beginning of the sabbatical or extended leave to ensure records and operations are maintained.

- Licensees shall arrange for another Licensee or the RSO to oversee ongoing operations and records keeping and be available to laboratory personnel for routine or emergency assistance, OR
- Transfer all radioactive materials to the RSO for disposal or storage if space is available.

XVIII. SPECIAL REQUIREMENTS FOR USERS OF SEALED SOURCES

Sealed sources are those which are permanently bonded or fixed in a capsule or matrix designed to prevent release and dispersal of the radioactive material under the most severe conditions that are likely to be encountered in normal use and handling. Therefore, no sealed source should be opened, or the contents removed.

Some sealed sources may be capable of generating significant radiation fields when in use or when removed from storage. However, sealed sources should never leak radioactive materials if used in accordance with the manufacturer's guidance. For this reason, radioactive contamination is highly unlikely. Sealed source leak tests are used to confirm and document the integrity of the source encapsulation and the absence of contamination. Leak test results are kept in units of becquerel or microcurie and retained for a period of 5 years.

Users authorized to possess sealed sources are required to:

- Perform sealed source leak tests monthly in addition to the biannual leak test performed by the RSO;
- Maintain accurate inventories of sealed sources, especially portable ones, to ensure they are on-hand and in their proper place;
- Define a storage area which has adequate security;
- Conduct or arrange for the RSO to conduct storage radiation surveys:
    - When initially establishing the storage location;
    - When changing a storage location;
    - When adding a gauge to a storage location; OR
    - When the occupancy of the areas adjacent to the storage location are changed.
- Ensure that only persons who have been properly trained may have access to or operate sealed sources;

- Ensure that sources are transported with adequate protection to prevent damage to the source in the event of an accident;
- Licensees and/or the RSO shall not hold sources or devices that are not in use (aka in storage) or for longer than 24 months following the last activity use unless prior authorization is granted by TDSHS.
- Sealed sources found to be leaking (greater than 0.005 uCi) shall be withdrawn from use and action taken to prevent contamination. Within two years of detecting the leak, the source should be repaired, or disposed.

A. Irradiator Use: C-60

Irradiators are devices used to provide a uniform gamma dose to small biological samples and materials. Most irradiators contain the following major components: a radioactive source, shielding, a sample chamber, and a control panel. Some models may have an air supply to provide the sample chamber with ventilation.

The irradiator in use currently is designed to minimize the radiation reaching the exterior surface of the device. During normal operation there is minimal hazard to users.

Irradiators do not cause induced radioactivity; in other words, the material subjected to the gamma radiation, at the energies produced by this type of irradiator, does not become radioactive.

Enhanced security devices are required by regulation.

This gamma radiation facility, which utilizes C-60, is locked in the Graduate Research Building, Rm. 144 on the Denton campus. Keys are issued to Authorized Users only and are their responsibility.

When utilizing the irradiator, radiation badges must be worn. For each exposure, enter the information in the log entry which is at the irradiator. If you have timed or prolonged exposure, reserve your time on the log.

ATTACHMENT A- Glossary of Terms

"**Absorbed dose**" means the energy imparted by ionizing radiation per unit mass of irradiated material. The units of absorbed dose are the rad and the gray (Gy). 1 Gy = 100 rad.

"**Activity**" means the rate of disintegration or transformation or decay of radioactive material. The units of activity are "disintegrations per second (or minute)" (dps or dpm), curie (Ci) and the becquerel (Bq).1 Ci = 37,000,000,000 dps (3.7 x 1010 dps)
1 Ci = 2,220,000,000,000 dpm (2.22 x 1012 dpm)
1 Bq = 1 dps

"**Adult**" means an individual 18 or more years of age.

"**Agreement State**" means a state which has executed an agreement with the U.S. Nuclear Regulatory Commission transferring to the state the responsibility for regulating uses of certain radioactive materials within its borders. Texas is an agreement state.

"**Agency**" means the Texas Department of State Health Services which runs the Radiation Control Program under the Division for Regulatory Services.

"**Airborne radioactive material**" means any radioactive material dispersed in the air in the form of dusts, fumes, particles, mists, vapors, or gases.

"**Airborne radioactivity area**" means a room, enclosure, or area in which airborne radioactive materials exist in concentrations:
1) In excess of the derived air concentrations (DACs) specified in 25 TAC 289.202 Appendix B, Table I, Column 1; OR
2) to such a degree that an individual present in the area without respiratory protective equipment could exceed, during the hours an individual is present in a week, an intake of 0.6 percent of the annual limit on intake (ALI) or 12 DAC-hours.

"**Annual Limit on Intake (ALI)**" means the derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year.

"**As Low As Reasonably Achievable (ALARA)**" means making every reasonable effort to maintain exposures to radiation as far below regulatory dose limits as is practical, consistent with the purpose for which the licensed or registered activity is undertaken, taking into account the state of technology, the economics of improvements in relation to benefits to public health and safety, and other societal and socioeconomic considerations, and in relation to utilization of ionizing radiation and licensed sources of radiation in the public interest.

"**Authorized User**" means any appropriately trained individual (including faculty, staff, students, volunteers, visiting researchers etc.) working with radioactive materials or radiation producing devices under the direction of a licensee. The term includes licensee's as well.

"**Background radiation**" means 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. "Background radiation" does not include sources of radiation from radioactive materials regulated by the Texas Bureau of Radiation Control (BRC).

"**Becquerel (Bq)**" means the System International (SI) unit of activity. One becquerel is equal to 1 disintegration or transformation per second (dps).

"**Bioassay**" means 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.

"**Biological radioactive waste**" means *radioactive material* mixed with biological components including animals, animal parts, excrement, bedding and/or biological cultures that may putrefy.

"**Byproduct material**" means:
1) any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material; and
2) the tailings or wastes produced by or resulting from the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content, including discrete surface wastes resulting from uranium solution extraction processes, and other tailings (or wastes) having similar radiological characteristics.

"**CFR**" means Code of Federal Regulations.

"**Committed dose equivalent (HT,50 or CDE)**" means the dose equivalent to organs or tissues of reference (T) that will be received from an intake of radioactive material by an individual during the 50-year period following the intake.

"**Committed effective dose equivalent (HE,50 or CEDE)**" means the sum of the products of the weighting factors applicable to each of the body organs or tissues that are irradiated and the committed dose equivalent to each of these organs or tissues (HE,50 = ▫ WT,HT,50).

"**Curie (Ci)**" means a unit of measurement of activity. One curie (Ci) is that quantity of radioactive material that decays at the rate of 3.7 x 1010 disintegrations per second (dps). Commonly used sub-multiples of the curie are the millicurie and the microcurie.
One millicurie (mCi) = 1 x 10-3 curie = 3.7 x 107 dps.
One microcurie (µCi.) = 1 x 10-6 curie = 3.7 x 104 dps.
One nanocurie (nCi) = 1 x 10-9 curie = 3.7 x 101 dps.
One picocurie (pCi) = 1 x 10-12 curie = 3.7 x 10-2 dps.

"**Declared Pregnant Woman**" means a woman who voluntarily informed her employer, in writing, of her pregnancy and the estimated date of conception.

"**Deep dose equivalent (Hd or DDE)**" which applies to external whole body exposure, means the dose equivalent at a tissue depth of 1 centimeter (1000 mg/cm2).

"**Depleted uranium**" means the source material uranium in which the isotope uranium -235 is less than 0.711 weight percent of the total uranium present. Depleted uranium does not include special nuclear material.

"**Derived Air Concentration (DAC)**" means the concentration of a given radionuclide in air which, if breathed by Reference Man (1.2 cubic meters of air per hour) for a working year of 2,000 hours under conditions of light work, results in an intake of one ALI.

"**Dose**" is 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.

"**Dose equivalent (HT)**" means the product of the absorbed dose in tissue, quality factor, and all other necessary modifying factors at the location of interest. The units of dose equivalent are the sievert (Sv) and rem. 1 Sv = 100 rem.

"**Dose limits**" means the permissible upper bounds of radiation doses established in accordance with these rules. For purposes of the rules, "limits" is an equivalent term.

"**Dosimeter**" means devices designed to be worn by a single individual for the assessment of dose equivalent. Examples of individual monitoring devices are film badges, thermoluminescent dosimeters (TLDs), and pocket ionization chambers.

"**Effective dose equivalent (HE)**" means the sum of the products of the dose equivalent to each organ or tissue (HT) and the weighting factor (WT) applicable to each of the body organs or tissues that are irradiated (HE = ▫ WTHT).

"**Embryo/fetus**" means the developing human organism from conception until the time of birth.

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

"**Exposure**" means the quotient of dQ by dm where "dQ" is the absolute value of the total charge of the ions of one sign produced in air when all the electrons (negatrons and positrons) liberated by photons in a volume element of air having mass "dm" are completely stopped in air. The unit of exposure is the coulomb per kilogram (C/kg) or the roentgen (R). 1 R = 2.58 x 10-4 C/kg.

"**Exposure rate**" means the exposure per unit of time, typically milliroentgen per hour (mrem/h).

"**External dose**" means that portion of the dose equivalent received from any source of radiation outside the body.

"**Extremity**" means 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.

"**Eye dose equivalent (LDE)**" means the external dose equivalent to the lens of the eye at a tissue depth of 0.3 centimeter (300 mg/cm2).

"**Gray (Gy)**" means the System International (SI) unit of absorbed dose. One gray is equal to an absorbed dose of 1 joule per kilogram (100 rad).

"**Healing arts**" means any system, treatment, operation, diagnosis, prescription or practice for the ascertainment, cure, relief, palliation, adjustment or correction of any human disease, ailment, deformity, injury, or unhealthy or abnormal physical or mental condition.

"**High radiation area**" means an area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.1 rem (1 millisievert) in 1 hour at 30 centimeters from any source of radiation or from any surface that the radiation penetrates.

"**Human use**" means the internal or external administration of radiation or radioactive material to human beings for healing arts purposes or research and/or development. Human use is specifically prohibited under all licenses issued to Texas Woman's University.

"**Individual**" means any human being.

"**Internal dose**" means that portion of the dose equivalent received from radioactive material taken into the body.

"**Ionizing radiation**" means 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.

"**License**" means a form of permission given by the Texas Department of State Health Services (TDSHS) Division for Regulatory Services, Radiation Control Program, or the U.S. Nuclear Regulatory Commission (NRC) to an applicant (in our case, Texas Woman's University) who has met the requirements for licensing set out by that Agency (TDSHS or U.S. NRC)

"**Licensed material**" means radioactive material received, possessed, used, or transferred under a license issued by the Texas Department of State Health Services, Division for Regulatory Services, Radiation Control Program or the U.S. Nuclear Regulatory Commission.

"**Licensee**" regulatorily means any person or organization who is licensed by the Texas Department of State Health Services, Division for Regulatory Services, Radiation Control Program or the U.S. Nuclear Regulatory Commission. Under the regulatory definition, TWU is the licensee. For the purposes of this document Licensee means those persons listed on the TWU Radioactive Materials License and those persons who have radiation producing equipment on the TWU X-Ray Registration.

"**Lost or missing source of radiation**" means a source of radiation whose location is unknown. This definition includes licensed material that has been shipped but has not reached its planned destination and whose location cannot be readily traced in the transportation system.

"**Liquid radioactive waste**" means any liquid that has radioactive material suspended or incorporated into it.

"**Member of the public**" means any individual, except an individual who is performing assigned duties for a licensee or registrant involving exposure to sources of radiation.

"**Minor**" means an individual less than 18 years of age.

"**Natural radioactivity**" means radioactivity of naturally occurring nuclides whose location and chemical and physical form have not been altered by man.

"**Occupational dose**" means the dose received by an individual in the course of employment in which the individual's assigned duties involve exposure to sources of radiation. Occupational dose does not include dose received from background radiation, as a patient from medical practices, from voluntary participation in medical research programs, or as a member of the public.

"**Permit**" means a form of permission given by the TWU Radiation Safety Committee to an applicant (faculty of Texas Woman's University) to possess, store, and/or use radioactive material or radiation producing devices under the authority granted to TWU in the applicable License. A Permit is issued to one individual; never to a department, office or group of individuals.

"**Quality factor (Q)**" means the modifying factor that is used to derive dose equivalent from absorbed dose.

Radiation	Quality Factor
Beta	1
Gamma	1
X-ray	1
Alpha	20
Neutron	varies from 3 - 10

"**Rad**" means the special unit of absorbed dose. One rad is equal to an absorbed dose of 100 erg per gram or 0.01 joule per kilogram (0.01 gray).

"**Radiation**" means one or more of the following:

1) Gamma and x rays; alpha and beta particles and other atomic or nuclear particles or rays;
2) Stimulated emission of radiation from any electronic device to such energy density levels as to reasonably cause bodily harm; OR
3) 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**" means 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 millisievert) in 1 hour at 30 centimeters from the source of radiation or from any surface that the radiation penetrates.

"**Radiation machine**" means any device capable of producing ionizing radiation except those devices with radioactive material as the only source of radiation.

"**Radiation safety officer (RSO)**" means an individual who has a knowledge of, and the authority and responsibility to apply appropriate radiation protection rules standards, and practices, and who must be specifically authorized on a certificate of registration or radioactive material license.

"**Radioactive material**" means any material (solid, liquid, or gas) that emits ionizing radiation spontaneously.

"**Radioactivity**" means the disintegration of unstable atomic nuclei with the emission of radiation.

"**Radiobioassay**" (See "Bioassay").

"**Rem**" means the special unit of any 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).

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

"**Roentgen (R)**" means the special unit of exposure. One roentgen (R) equals 2.58 x 10-4 coulombs/kilogram of air. (See "Exposure").

"**Sealed source**" means radioactive material that is permanently bonded or fixed in a capsule or matrix designed to prevent release and dispersal of the radioactive material under the most severe conditions that are likely to be encountered in normal use and handling.

"**Shallow dose equivalent (HS or SDE)**" which applies to the external exposure of the skin or an extremity, means the dose equivalent at a tissue depth of 0.007 centimeter (7 mg/cm2) averaged over an area of 1 square centimeter.

"**Sievert**" means the System International (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 material**" means:
1) Uranium or thorium, or any combination thereof, in any physical or chemical form; OR
2) Ores that contain by weight 0.05 percent or more of:
    a) Uranium;
    b) Thorium; OR
    c) Any combination thereof.

"Source material" does not include special nuclear material.

"**Special nuclear material**" means:
1) Plutonium, uranium-233, uranium enriched in the isotope 233 or in the isotope 235, but does not include source material; OR
2) Any material artificially enriched by any of the foregoing, but does not include source material.

"**Survey**" means to take measurements of levels of radiation or concentration of radioactive material present.

"**Total effective dose equivalent (TEDE)**" means the sum of the deep dose equivalent for external exposures and the committed effective dose equivalent for internal exposures.
TEDE = DDE + CEDE

"**Total organ dose equivalent (TODE)**" means the sum of the deep dose equivalent and the committed dose equivalent to the organ receiving the highest dose.
TODE = DDE + CDE

"**Trefoil symbol**" means the universal radiation warning symbol.

"**Unrestricted area**" means an area, access to which is neither limited nor controlled by the licensee (or Authorized User).

"**Whole body**" means for purposes of external exposure, head, trunk (including male gonads), arms above the elbow, or legs above the knees.

"**Worker**" means an individual engaged in work under a license or a Permit.

ATTACHMENT B – Declaration of Pregnancy Form

Section I. Voluntary Declaration of Pregnancy

In accordance with the Texas regulations for Control of Radiation in 25 TAC 289.202 (m) (1), "Dose equivalent to an embryo/fetus", I voluntarily declare that I am pregnant. My estimated date of conception is (month and year) _____ as regulatory required.

I understand that the dose equivalent to my embryo/fetus during my entire pregnancy will not be allowed to exceed 0.5 rem (5 mSv), unless this limit has already been exceeded between the time of conception and the date of declaration as stated. By attesting this document, I understand that I have met the definition of a declared pregnant woman[1].

_____ _____

Signature and Date Employee/Student ID

_____

Name (Printed)

Section II. Rescinding Pregnancy Declaration

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

I, _____, declare that I no longer wish to be considered a declared pregnant woman.

_____ _____

Signature and date Employee/Student ID

[1] 125 TAC 289.202 (c) (7) defines a declared pregnant woman as: A woman who has voluntarily informed the licensee, in writing, of her pregnancy and the estimated date of conception. The declaration remains in effect unless the declared pregnant woman voluntarily withdraws the declaration in writing or is no longer pregnant.

XIX. ATTACHMENT C – Application to Use Radiation Producing Equipment

TWU is required by state law to register each radiation producing equipment or device. This includes x-ray machines, electron microscopes, bone densitometers, and atomic absorption. The Licensee is the person who will be responsible for the safe use of the radiation producing equipment. Submit the completed form to the RSO.

Licensee Name				Department	
Building & room number where device will be stored					
Phone Number		Email Address			
Type of device (e.g. analytical x-ray, diffraction x-ray, densitometer)					
Device manufacturer		Device model number		Device serial number	
TWU inventory control tag		Maximum kVP of device		Maximum mA of device	
Number of x-ray tubes		□ 0 □ 1 □ 2		□ µCi □mCi	
Interlocks/safety engineered into the device					
Intended use of device					
Training & experience of applicant regarding devices of this type					

Provide a sketch of the room or lab with device placement indicated. Also indicate occupational uses of nearby areas. Attach the sketch on a separate page.

Others authorized to use this equipment

Name	Title	Role

Signature of Applicant		Date	
RSO Approval		Date	
Department Head Approval		Date	

ATTACHMENT D – Application to Use Radioactive Materials

TWU is required by state law to obtain a license for the use of radioactive materials used in teaching or research. The Licensee is the individual who will be responsible for the safe use of the radioactive material(s). Complete the following information in full and submit to the RSO.

Name of applicant		Department	
Building & room number(s) where material will be stored			
Phone Number		Email Address	
Training & experience of applicant regarding radioactive materials			
Radioisotope		Chemical & Physical Form	
Maximum to be used per experiment		□ µCi	□mCi
Maximum to be ordered per shipment		□ µCi	□mCi
Estimated order per year		□ µCi	□mCi
Brief title & objective of the study involved			
Method to be used □ procedure notes attached			

Room involved for each aspect of the work

Experiments	Radioisotope Storage	Sample Counting	"Hot Sinks"	Waste Storage	Animal Housing	Monitoring of Radioactivity
				□ solid □ liquid □ gas □ animal		

Method of radioactive disposal			
Signature of Applicant		Date	
RSO Approval		Date	
Department Head Approval		Date	

ATTACHMENT E – Radioisotope Purchase Requisition

Principal Investigator		Date	
Department		Phone	

Signature	
Radioisotope	
Form	
Activity	
Quantity	
Lot No.	
Price	
Physical Half-Life	
Kind of Radiation	
Energy of Radiation	
Vendor Name	

XX. ATTACHMENT F – Radiation Survey Form

Licensee (Lab):_____ Building/Room #: _____

Radioisotopes Used: _____ Surveyor Name: _____

Contamination Survey - If wipe test - Surfaces are wipe tested for radioactive contamination in a random fashion. An area of approximately 100 cm sq. is covered by each wipe. Results are reported as disintegrations per minute (dpm). If Geiger-Müller counter used, survey surfaces as close as possible without touching. Geiger-Müller counter not suitable for all isotopes and wipe test only works for removable contamination.
Radiation Survey – Radiation dose rates are measured at work areas and storage areas, using Geiger-Müller counter where appropriate. Survey ≤1 foot from radioactive material/waste storage areas and in areas where materials are used.

RADIATION SURVEY

	Manufacturer	
	Model	
	Serial #	
	Calibration Date	
	Background	
	Survey Levels	
	Description of Area Surveyed	

CONTAMINATION SURVEY

	Manufacturer	
	Model	
	Serial #	
	Calibration Date	
	Background	
	Survey Levels	
	Description of Area Surveyed	

Indicate radiation levels in the table and/or map. Mrem/hr for Geiger readings, background corrected dpm if wipe test. Printout of scintillation counter results can be used to note wipe test results.

XXI. ATTACHMENT G – Sealed Source Leak Test Form

GENERAL	
SURVEYOR NAME:	DATE:
BUILDING:	ROOM NO:

SOURCE	
DESCRIPTION (e.g. irradiator):	SOURCE SERIAL NUMBER:
ISOTOPE:	ACTIVITY:

SURVEY INSTRUMENT	
MAKE:	MODEL:
SERIAL NUMBER:	

RESULTS	
CONTAMINATION (uCi):	COMMENTS:

* Contamination limit = 0.005 uCi or more of removable contamination on any test sample (per 25 TAC 289.201(g))

ATTACHMENT H – Radioactive Materials Inventory & Usage Sheet

Radioisotope: _____
Purchase date: _____
Lot No.: _____
Vendor: _____
Amount of Radioisotope (mCi): _____
Person receiving material: _____
Storage Location: _____
Transferred to: _____
Date of Transfer: _____
Amount Transferred: _____

RECEIPT SURVEY

Visual: _____

Meter Survey: _____
* action level > 200 mrem/hour

Contamination?: _____
* action level > 22 dpm/cm^2

If action level exceeded contact RSO immediately.

DATE	AMOUNT USED (mCi)	USAGE LOCATION	DISPOSAL LOCATION	NAME	Comments

Instructions: Use one Inventory Materials Sheet per radioisotope container purchased. Upon receipt of radioisotope, complete the Receipt Survey section in the upper right pursuant to Section XI.B. of this manual. Complete all fields as applicable. Utilize this form for both inventory and tracking amount used each time. Submit a copy of this form to the RSO monthly. Information pertaining to the activity level (in mCi) of radioisotopes will be utilized on the Waste Container Log (Attachment I).

XXII. ATTACHMENT I – Waste Container Log

Radioisotope	Activity (in mCi)	Date	Waste Description & State (e.g. biological liquid, non-biological solid, etc.)	Chemical Waste Constituents For mixed wastes only: scintillation fluids, solvents (phenol, chloroform), etc.	Name

Instructions: Utilize the half-life corrected Activity (in mCi) for this log. Please document each time waste is placed into its designated container.

ATTACHMENT J – Decay in Storage Log

Radioisotope	Date of Disposal	Surveyor Name	Background Radiation Level	Radiation Level At Surface of Container	Manufacturer, Model & Serial number of Survey Meter	Comments

ATTACHMENT K- Training Record and Acknowledgement Form

Trainee		Department	
TWU Username		PI/Instructor	

Radiation Producing Equipment Complete the activities below if operating radiation producing equipment. Otherwise, mark N/A.		
Initial	**Date**	**Learning Activity**
		Complete Radiation Safety Training ☐ Initial ☐ Annual refresher
		Review the operating and safety procedures and know how to access them
		Understand the lab policy regarding proper lab attire (long pants, closed-toe shoes) and personal protective equipment (PPE) (lab coat, safety glasses, protective gloves, etc.)
		Know the hazards, required PPE, protocols for safe operation of equipment, area restrictions, security procedures, posting locations for required signs, incident reporting procedures, etc.

Radioactive Material Complete the activities below if utilizing radioactive material. Otherwise, mark N/A.		
Initial	**Date**	**Learning Activity**
		Complete Radiation Safety Training ☐ Initial ☐ Annual refresher
		Review the Radiation Safety Manual and know how to access it
		Understand the lab policy regarding proper lab attire (long pants, closed-toe shoes) and personal protective equipment (PPE) (lab coat, safety glasses, protective gloves, etc.
		Know the hazards, required PPE and/or engineering controls, signs of exposure, safe handling, storage and disposal, area restrictions, security procedures, posting locations for required signs, incident reporting procedures etc. of all relevant radioactive material
		Identify acceptable areas for food storage and consumption
		Know how to conduct appropriate survey methods and how to document surveys
		Know proper procedures for collection, storage, and disposal of radioactive material, as well as required documenting procedures
		Recognize that all radioactive material contamination, regardless of how seemingly insignificant, must be cleaned up immediately
		Know how to handle spills and emergencies including cleaning small spills (if safe to do so and proper equipment available) and reporting and evacuating for large/hazardous spills or other emergencies

By signing this document, I acknowledge that I have received training regarding each of the above items. If I do not understand something or need further training, I can request it at any

time. I understand that it is my responsibility to know the hazards associated with the materials I use, and to protect myself and others from those hazards. In addition, I will strive to maintain awareness of peripheral or adjacent hazards. I acknowledge that safety is an inherent responsibility to which each individual must commit. I also recognize that unsafe practices will not be tolerated.

_____	_____	
Name of Trainee (printed)	Name of Trainer (printed)	
_____	_____	_____
Signature of Trainee	Signature of Trainer	RSO Initial
_____	_____	
Today's Date	Today's Date	

XXIII. ATTACHMENT L – Radioisotopes in Animals

Overview

- Injection of animals with radioisotopes will be performed in a designated radiation laboratory/area, preferably in a hood.
- Radioactive animals will be housed in a designated radiation laboratory/area.
- A sketch and description of the animal housing facilities used for each respective experiment using radioisotopes must be developed and shared with animal caretakers.
- Instructions for handling animals, carcasses, and for cleaning and decontamination of animal cages shall be developed and shared with animal caretakers.
- Cages containing radioactive animals must have a "Caution Radioactive Material" label on them. Also post an information next to the cages which include:
    - Identify of the radioisotope(s) used.
    - Maximum amount given per group of animals and date of administration.
    - Radiation emitted in mrem/hour at 1 meter, per group of animals.
- Radiation emitted at cage surfaces must never exceed 2mrem/hr unless adequate shielding is provided by the investigator to reduce the amount of radiation received by the neighboring animals to less than 2 mrem/hr.

The Licensee is responsible for the radioactive animals, their housing, and their ultimate disposal.

All excreta are to be disposed of by the investigator, using procedures given in the Radioactive Waste Disposal section. Feeding and watering of the animals given radioisotopes are responsibilities of the Licensee.

All animal care equipment used with animals given radioisotopes must be washed, rinsed, and monitored by the Authorized User before routine cleaning.

Radioactivity must be non-detectable with an ordinary beta-gamma survey meter. A suitable meter is available in the animal care radioisotope area. For beta energies less than 0.3 MeV, a thin-window GM tube (2 mg/cm^2) instrument, must be used. If the investigator is unable to get a thin-window instrument, he should call the RSO.

- Animals which are irradiated with C-60 are themselves do not become radioactive and thus are exempt from the conditions listed above.

Radiation Monitoring

When working with radioisotopes easily detected with a Geiger-Muller (GM) counter (e.g.P-32), place the GM counter next to work area and turn it on. This will allow you to check hands and equipment without worrying about contaminating the meter when turning it on.

While working with animals, check hands and sleeves regularly to assure no contamination has occurred. Change gloves often and check feet before leaving the area.

The area occupied by animals and equipment must be monitored at the termination of the experiment.

The Licensee is responsible for monitoring the following areas at least once each week:

- Floor of the room housing the animals
- Waste holding areas, including excreta
- Sink at which equipment is washed

A record of all monitoring must be kept by the Licensee.

Precautions According to Radioisotope

Isotope:	**EXPOSURE HAZARD AND CONTAMINATION HAZARD- EXPOSURE LEVELS *CAN* BE DETERMINED WITH A SURVEY METER**
P-32 **Cs-137** **Zn-65** **I-125** **Cr-51**	Personal Protective Equipment Handlers should wear double gloves, lab coat, and eyewear. Any equipment coming into contact with bodily fluids from these animals should either be disposable or be decontaminated before released from the area. Waste generated from these animals must be disposed of in proper radioactive waste containers. Exposure Reduction Methods **Time -** Try to minimize the time spent with animals containing this isotope. **Distance-** Increasing distance between you and exposure source, greatly minimizes exposure levels. Do not hold animals for extended periods of time. **Shielding -** When possible, use shielding between you and the exposure source. Plexiglas or plastic should be used for beta isotopes like P-32. Lead or aluminum should be used for gamma isotopes like Cs-137, I-125, Zn-65 and Cr-51.

Isotope: C-14 H-13 Ca-41 Ca-45 S-35	**CONTAMINATION HAZARD ONLY. NO EXPOSURE HAZARD UNLESS INGESTED- THESE ISOTOPES *CANNOT* BE EASILY DETECTED WITH A SURVEY METER** Personal Protective Equipment: Handlers should wear double gloves, lab coat, and eyewear. Any equipment coming into contact with bodily fluids from these animals should either be disposable or be decontaminated before released from the area. Waste generated from these animals must be disposed of in proper radioactive waste containers.

ATTACHMENT M – Guidance on Specific Radioisotopes

Radioisotope	C-14
General	This material is expensive to purchase and dispose of. Please only order necessary quantities.
Physical Data	• Energy type: beta (Max: 156 keV) • Half-life: 5730 years • Max range in air: 240mm
Shielding	• Total absorption in 0.2mm of glass or 0.3mm of plastic • None required
Precautions	• Handle volatile & dusty compounds in a fume hood. • Wear gloves, lab coat, and safety glasses. Double gloves may be required. • Due to long half-life, contaminated clothing and shoes should be properly disposed of.
Dosimetry/Survey Requirements	• Liquid scintillation counter & wipe tests • Geiger-Müller counter with pancake probe has poor efficiency (5-8%); if utilized, survey technique is slow and close to the surface without touching. • Urine assays may be required after spills or contamination incidents.
Radioisotope	**H-3 (Tritium)**
General	Tritium is not a radiation hazard until it enters the body. May be absorbed into the skin or enter through cuts/abrasions.
Physical Data	• Energy type: beta (Max-18.6 keV) • Half-life: 12.35 years • Max range in air: 6mm
Shielding	• Total absorption in <0.1mm of glass or plastic • None required
Precautions	• Handle tritiated water, gases & volatile liquids in fume hood. • Use glass containers to store tritium compounds, because tritiated water & organic solvents will pass through plastic. • Recommend disposal of H-3 when finished using material; despite long half-life, chemically it degrades and may not be useful. • Wear gloves, lab coat, and safety glasses. Double gloves may be required.

Dosimetry/Survey Requirements	• Liquid scintillation counters & wipe tests (required after each use)
	• Routine urine assays would be required for handling more than 100mCi of H-3.
	  o Geiger-Müller counters are **not** appropriate.
	  o Film badges & ring dosimeters are **not** appropriate

Radioisotope	P-32
General	A high-energy beta emitter, the bone is the critical organ for uptake of transportable compounds of P-32, with lung and lower intestine being the critical organs for inhalation and ingestion, respectively.
Physical Data	• Energy type: beta (Max: 1.71 MeV) • Half-life: 14.3 days • Max range in air: 7.9m
Shielding	• Total absorption 3.4mm glass or 6.3mm Plexiglass; lead on the outside of the plexiglass can decrease bremsstrahlung emissions, if needed. • 3/8" plastic/Plexiglass at minimum
Precautions	• All volatile compounds must be used in a fume hood. • Never work over an open container with P-32; use proper shielding. • Keep handing time to a minimum. • Use plastic tongs and plastic syringe shields to avoid direct skin contact. • Wear safety glasses. • Wear gloves, lab coat, and safety glasses. Double gloves may be required. • Survey frequently. • If clothing items become contaminated, items may be returned after 12 half-lives.
Dosimetry/Survey Requirements	• Film badges or ring dosimeters suitable. • Urine assays may be required after spills and contamination incidents. • Liquid scintillation counter • Geiger-Müller counter with pancake probe (20-35% efficient)
Radioisotope	**P-33**
General	P-333 is less energetic than P-32.
Physical Data	• Energy type: beta (Max: 76.6 keV) • Half-life: 25.4 days • Max range in air: 500mm
Shielding	• Plexiglass is appropriate.
Precautions	• All work with volatile compounds must be performed in a fume hood. • Wear gloves, lab coat, and safety glasses. Double gloves may be required.
Dosimetry/Survey Requirements	• Liquid scintillation counter. • Urine assays may be required after spills and containment incidents. • Film badges and dosimeter rings are **not** appropriate. • Geiger-Müller counters are only about 10% efficient; may be used if the meter is approved and calibrated for C-14 measurements.

Radioisotope	S-35
General	Many S-35 compounds are volatile or degrade, giving off volatile products. Take care not to generate Sulphur dioxide or hydrogen sulfide which could be inhaled. Sulphur dioxide: irritant to eyes, nose, throat and lungs; bronchoconstriction; mutagen; suspect reproductive effects. Hydrogen sulfide: irritant to eye, lung; acute system toxicity; CNS may be affected. Sulphur is combustible. S-35 generally does not pose an external dose hazard, but can pose internal hazards if on bare skin, ingested or breathed in.
Physical Data	• Energy type: beta (Max: 167.5 keV) • Half-life: 87.44 days • Max range in air: 260mm
Shielding	• Total absorption in 0.2mm of glass or 0.3mm of plastic • None required
Precautions	• Always conduct procedures with S-35 in a fume hood. • Select appropriate gloves for chemicals handled. • Wear gloves, lab coat, and safety glasses. Double gloves may be required. • Large quantities (>10mCi) stored at -80 can cause local contamination of freezer; large stock vials should be placed in secondary storage container and activated charcoal should be incorporated into container.
Dosimetry/Survey Requirements	• Liquid scintillation counter • Urine assays may be required after spills and contamination incidents. • Film badges and dosimeter rings are **not** appropriate. • Geiger-Müller counters with pancake probe are only about 5-8% efficient; if utilized, survey technique is slow and close to the surface without touching.

ATTACHMENT N – Dosimeter Request Form

Name: _____
E-mail: _____
PI/Licensee: _____
Department: _____
Job Title/Position: _____

PRIOR DOSE STATEMENT

I hereby certify that, to the best of my knowledge, my total occupational radiation dose from sources other than Texas Woman's University is:

- ☐ None (I have received no prior occupational dose)
- ☐ I have been monitored for radiation dose at another place of employment in the past/currently

Please list prior employer(s) and dates of exposure:

_____

RADIATION SAFETY TRAINING STATEMENT

I hereby certify that I understand the following, and agree to the terms and conditions of use for dosimetry badges:

- ☐ I have completed all applicable Radiation Safety Training
- ☐ Radiation dosimeters shall not be deceptively exposed. *Intentional* deceptive exposures of dosimeters are forbidden and may result in enforcement actions.
- ☐ Dosimeters are issued to only one person. Dosimeters shall not be shared.
- ☐ Dosimeters in storage and not being worn shall not be stored near sources of radiation.
- ☐ Dosimeters should not be removed from campus; this is to avoid potentially damaging or deceptively exposing the dosimeter.
- ☐ Licensees shall notify the RSO immediately upon learning of possible deceptive exposures of dosimeters, or if the dosimeter is lost or damaged.

Signature:

_____

RADIATION SAFETY OFFICE USE ONLY

- ☐ The individual is **not** likely to receive exposures requiring monitoring per TAC 25 §289. Personal dosimetry is not necessary.
- ☐ The individual is **not** likely to receive exposures requiring monitoring per TAC 25 §289. Personal dosimetry is not necessary.

Exposure Request	Badge(s) Issued	Training Complete?