

# Radiation Safety Manual

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Environmental Health, Safety and Risk Management Department  
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## INTRODUCTION

The Radiation Safety Manual at Stephen F. Austin State University (SFA) exists to protect employees, students, and visitors as well as the public and the environment from the harmful effects of exposure to ionizing and nonionizing radiation. SFA is committed to meeting all applicable state and federal regulatory requirements and to keeping doses from licensed sources of radiation As Low As Reasonably Achievable (ALARA).

This procedure manual has been developed in compliance with Texas Health and Safety Code Ch. 401, 25 Tex. Admin. Code § 289, UTS 174 (Environmental Health and Safety) and SFA Handbook of Operating Procedures (HOP) 05-514 (Radioactive or Radiation-Producing Materials or Equipment). The policy is available online at: <https://www.sfasu.edu/docs/hops/05-514.pdf>

This manual is issued and maintained by the SFA Environmental Health, Safety, and Risk Management Department (EHSRM). It is divided into two separate parts:

1. Part One: Radiation Producing Equipment Procedures
2. Part Two: Radioactive Materials Procedures

Definitions of technical terms contained in this manual are given in Appendix A on page 28. Additional information on laboratory safety and hazardous waste management, as it relates to radiation safety, can be found in the SFA Laboratory Safety and Hazardous Waste Manuals. These are separate manuals and are available on the EHSRM website: <http://www.sfasu.edu/safety>.

## **PART ONE: RADIATION PRODUCING EQUIPMENT PROCEDURES**

### **I. PURPOSE AND SCOPE**

The purpose of part one of this manual is to ensure that all university activities, operations, and procedures involving the use of radiation producing equipment are performed in such a way as to protect the users, faculty, staff, students, and the general public from exposure. This part of the manual applies to all faculty and staff responsible for the use of radiation producing equipment which includes but is not limited to:

1. Human use medical x-ray machines;
2. Bone densitometers;
3. Diffraction x-ray machines;
4. Atomic absorption; and
5. Other licensed radiation producing equipment associated with research and education.

### **II. RESPONSIBILITIES**

#### **A. Environmental Health, Safety, and Risk Management Department, Radiation Safety Officer (RSO):**

The Department of Environmental Health, Safety, and Risk Management is responsible for radiation safety at SFA, and the Radiation Safety Officer (RSO) is responsible for the daily implementation of radiation safety in accordance with license/registration and regulatory requirements. Duties of the RSO include:

1. Oversee the purchase, receipt, storage, use, and disposal of radioactive or radiation-producing materials or equipment.
2. Ensure the most current legal requirements are identified and evaluated for compliance.
3. Establish, coordinate, and adhere to the radiation safety procedures outlined in this safety manual and to comply with regulatory requirements.
4. Inspect university laboratories and work areas, where radioactive materials or radiation producing equipment are used, for regulatory compliance and worker protection, or in response to a notice of a possible violation. In carrying out this duty, the RSO or designated representative shall have the authority to enter any university building, structure, room, office, or laboratory without prior notice to department supervisors, faculty, or staff. However, routine inspections are normally scheduled in advance.
5. Assist Authorized Users with meeting radiation safety training requirements
6. Serve as the official university contact for federal and state regulatory agencies regarding radiation safety compliance and communicate compliance requirements to university officials. These include, but are not limited to: United States Nuclear Regulatory Commission (NRC) and the Texas Department of State Health Services (TDSHS) Radiation Control Program.

#### **B. College Deans, Chairs, and Directors:**

1. Ensure the safe operations of all laboratories and other sites in the respective college or work area where radioactive materials or equipment are used;

2. Ensure compliance with all applicable regulatory requirements, as well as the university policy and procedures described in this manual;
3. Arrange for the payment of fees associated with the required state license or registration, and the purchase, storage, and disposal of radiation sources, as well as any other fees associated with compliance and safe use of radioactive materials and/or equipment;
4. Provide safety equipment and engineering controls as deemed necessary by the RSO;
5. Have independent enforcement authority to close a laboratory for safety or regulatory violations; and
6. Have the primary responsibility for the environmental health and safety of their faculty, staff, students, and visitors.

**C. Laboratory Supervisors and Authorized Users:**

1. Comply with all license and registration requirements, regulations, programs, and procedures specified by the RSO and the EHSRM Department.
2. Attend all required radiation safety training courses and use all required protective equipment, engineering controls, and safety precautions described in this manual and any applicable owner's manuals.
3. Handle all radioactive sources, radiation producing equipment, and radioactive waste in accordance with the SFA Radiation Safety and Hazardous Waste Manuals, and applicable state regulations.
4. Periodically inspect their laboratory or work area to ensure compliance with this manual and applicable regulations.
5. The Authorized User is responsible for all containment and clean-up actions in responding to spills and emergencies.
6. Notify the RSO of all incidents involving radioactive materials and radiation producing equipment. Report non-compliance issues or concerns to the RSO or to the director of EHSRM.

**D. Radiation Safety Committee (RSC)**

The EHSRM department will establish a Radiation Safety Committee when required by state regulations described in 25 TAC 289.252. The RSC will advise the EHSRM Director on matters related to radiation safety and recommend policies and procedures it deems appropriate to ensure an adequate radiation safety program.

The University Radiation Safety Committee (RSC) shall consist of the following:

1. The Radiation Safety Officer (RSO), who will chair the Committee;
2. The EHSRM Director (member of management);
3. One Authorized User of each type of radiation producing equipment;
4. One Authorized User of radioactive materials (when appropriate); and
5. Other members deemed appropriate by the RSO.

The RSC shall meet as often as needed to review:

1. New or changing uses of radiation producing equipment;
2. Changes in radiation safety staff and organizational structure;
3. Changes in regulations;
4. Radiation incidents and emergencies; and
5. Procedural changes.

Specific responsibilities of the RSC include:

1. Reviewing and approving applications for possession and use of radiation producing equipment and/or radioactive materials.
2. Notifying and advising 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.
3. Assist EHSRM in reviewing or auditing radiation safety program operations as needed.

The RSC will meet on an ad hoc basis to be in compliance with the Texas Department of State Health Services (TDSHS) Radiation Control Program as described in the Texas Administrative Code 25 TAC 289.252.

### **III. REGISTRATION AND REGULATORY REQUIREMENTS**

#### **A. University Registration of Radiation Producing Equipment**

SFA's current registration, R03844, issued by the Texas Department of State Health Services (TDSHS) includes specific conditions and regulations that apply to the use of equipment covered by the registration. A copy of the current SFA Registration and applicable state regulations are available upon request from the RSO. Contact the RSO at 468-6034, for more information on regulatory requirements.

Rules and procedures promulgated 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, and the Texas Health and Safety Code Ch. 401 (Texas Radiation Control Act).

#### **B. Authorization to Use Radiation Producing Equipment**

1. Any faculty or staff member at SFA may apply to use radiation producing equipment. An application form is provided in Appendix B of this manual, and also available on the EHSRM website at: <http://www.sfasu.edu/safety>.
2. Approval must be granted by the RSO prior to purchasing or using any radiation producing equipment on the SFA campus.
3. Only work that is authorized under the applicable registration may be performed. The RSO approval may include restrictions or limits on:
  - a) Location of use and/or storage of the radiation producing device; and,
  - b) Types of experiments authorized.
4. The RSO or the RSC may at any time place additional conditions or restrictions on an Authorized User for reasons of safety and/or compliance.
5. Radiation producing equipment shall not be used in or on humans unless specifically authorized.

### **IV. RADIATION DOSE LIMITS AND EXPOSURE CONTROL**

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 long-term effects such as cancer in the exposed individual.

State and federal regulations have established a system of dose limitation and minimization described in 25 TAC 289.202. 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 further minimize radiation doses to individuals and to groups of individuals to the extent practical, 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 is Reasonably Achievable.

### **A. Radiation Dose Limits**

1. Occupationally Dose Limits for Adults:
  - a) Total Effective Dose Equivalent (TEDE) - 5 rem/y (5,000 mrem/y)
  - b) Total Organ Dose Equivalent (TODE) - 50 rem/y (50,000 mrem/y)
  - c) Shallow Dose Equivalent (SDE) -50 rem/y (50,000 mrem/y)
  - d) Extremity Dose Equivalent -50 rem/y (50,000 mrem/y)
  - e) Lens (of Eye) Dose Equivalent (LDE) - 15 rem/y (15,000 mrem/y)
2. Dose to an Embryo/Fetus of a Declared Pregnant Woman (occupational exposure)
  - a) Total Effective Dose Equivalent (TEDE) - 500 mrem over entire pregnancy
  - b) TEDE should not vary substantially above 50 mrem in any month
3. Individual Members of the Public
  - a) 2 mrem in any one hour
  - b) Total Effective Dose Equivalent (TEDE) - 0.1 rem/y (100 mrem/y)

### **B. Exposure Control**

The only means of exposure from radiation producing equipment at SFA is external exposure. Common external exposure controls include the use of time, distance, and shielding to minimize radiation doses. In many X-ray devices the radiation is emitted in a primary beam. Any off-axis position from the beam reduces significantly the risk of exposure.

## **V. EMPLOYEE DOSE MONITORING**

Employee monitoring for radiation doses is done by dosimetry badge monitoring and analysis. The purpose of radiation dosimetry is to measure the radiation dose equivalent received by occupationally exposed individuals at SFA. 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 regulation 25 TAC 289.202(q)(1)(A) requires 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, most users of radiation producing equipment will not be monitored individually for external radiation exposure (will not receive dosimetry "badges") because of the very low radiation exposure associated with the equipment. In such cases, area dosimetry monitoring has previously been conducted to ensure exposures are minimal as expected. Area monitoring will be conducted for any new equipment for a period of one year to establish a baseline of radiation exposure associated with the equipment. If after one year the results prove to be less than the dose limits, area monitoring will be discontinued.



## Personal Radiation Dosimetry

1. Radiation dosimeters appropriate for the potential exposure will be issued and monitored by the EHSRM Department to the individual and shall be worn by SFA employees likely to receive, in one year, a dose in excess of 10% of the applicable dose limits.
2. The RSO and RSC shall determine the “likely to exceed 10%” status of an individual, the dosimeter type.
3. 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.
4. Radiation dosimeters shall not be deceptively exposed.
  - a) Dosimeters are issued to only one person. Dosimeters shall not be shared.
  - b) Dosimeters in storage and not being worn shall not be stored near sources of radiation.
  - c) Dosimeters should not be exposed to high heat, chemical or physical damage, or washed in a washing machine.
  - d) No person shall wear dosimeters issued by SFA while working for another employer or institution.
  - e) Authorized Users shall notify EHSRM if employees are concurrently working for another (non-SFA) employer and working with sources of ionizing radiation.
  - f) Dosimeters shall not be worn during personal medical or dental x-ray examinations.
  - g) Dosimeters shall not be worn after medical administration of radioactive materials (thyroid ablation therapy, cardiac stress tests, diagnostic nuclear medicine tests, etc.).
  - h) Authorized Users shall notify the RSO immediately upon learning of possible deceptive exposures of dosimeters.
  - i) Intentional deceptive exposures of dosimeters are forbidden and may result in enforcement actions.
  - j) Lost or damaged dosimeters shall be reported to the RSO as soon as possible.
5. Proper wearing of dosimeters:
  - a) Whole body dosimeters are the most common type of monitoring device worn by persons operating radiation producing equipment 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 Appendix A).
  - b) Persons who wear a leaded apron should wear whole body dosimeters outside of any leaded apron. Those who perform diagnostic x-ray and/or fluoroscopy procedures should normally wear the dosimeter at the collar.
  - c) Declared pregnant women, who wear dosimeters for fetal monitoring, shall wear the dosimeters on the abdomen. If a leaded apron is worn by the x-ray technician, the dosimeter should normally be placed on the abdomen, under the apron.
6. Authorized Users or their designees shall collect and return used dosimeters to EHSRM promptly after receiving replacement dosimeters at the beginning of a new wear period.
7. Any person who works with any source of radiation at SFA (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 the EHSRM Department upon request.

8. All individuals issued personal dosimetry will receive annual reports indicating their exposure.
9. Authorized Users shall be responsible for the costs associated with dosimetry services.

## VI. RADIATION SURVEYS AND POSTINGS

Radiation surveys are conducted by monitoring the area outside and adjacent to a restricted radiation equipment room to ensure that no radiation is escaping the restricted area and potentially exposing other workers or the general public. Radiation 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 radiation meter or by placing a dosimeter in the area to monitor over a specific time period. The EHSRM Department and the Authorized User must work together to ensure safety in the workplace and to protect both the public and the environment from the harmful effects of radiation.

### A. Radiation Levels

Radiation levels must be determined to prevent exposures from exceeding limits described in Section IV. Normally, radiation surveys are performed by area monitoring to measure exposure or dose rates from sources of radiation. Area monitoring has been, or will be conducted to verify radiation levels in unrestricted areas.

### B. Area Limits

Radiation levels must be maintained and limited as follows:

1. Less than 50 mrem in any one year in unrestricted areas ( $< 5.7 \mu\text{rem/hr}$ ) applies to long-term (typically greater than 8-hour) exposures.
2. In restricted areas, exposure rates should be kept ALARA (As Low As Reasonably Achievable). Generally, the goal should be to keep radiation levels less than 5 mrem per hour.

### C. Postings

The following signs are required:

1. **“Caution - X-ray Equipment”** signs shall be conspicuously posted on the entrance to each area or room containing operational X-ray equipment.
2. Signs and postings shall display the universal radiation symbol and be red, orange, or yellow in contrast to the surrounding environment.
3. Signs and postings should be removed when the radiation hazard no longer exists (e.g., equipment removed).
4. The control panel on the equipment shall be labeled in a conspicuous manner that cautions individuals that radiation is produced when it is energized.

## VII. TRAINING

All individuals who work with or (in some cases) near registered sources of radiation are required to complete radiation safety training conducted or approved by the RSO. The depth of the training must be commensurate with the level of hazard to which the individual is exposed. The level of training required may be determined by the RSO or RSC. All training must be documented using the Training Record and Acknowledgement Form located in Appendix C. No

individual shall be allowed to work unsupervised with sources of radiation until that person completes appropriate radiation safety training.

### **Basic Radiation Safety Training**

1. All individuals, including Authorized Users and student workers, who work with or are authorized to possess registered radiation producing equipment, are required to complete appropriate radiation safety training course(s) offered or approved by EHSRM.
2. Each Authorized User is responsible for providing and documenting laboratory-specific training, using the Training Record and Acknowledgement Form attached in Appendix C, to individuals (including students) who work with registered radiation producing equipment under their control. This training shall address, as applicable:
  - a) Area restrictions - where radiation producing equipment is used within the lab(s) and restrictions on that use;
  - b) Procedures for security;
  - c) Posting locations for required signs and notices;
  - d) Walk-through review of protocols involving radiation producing devices; and
  - e) Special handling techniques which will minimize exposures when using the equipment.
3. Training for individuals, who may be in the vicinity of the equipment during its operation shall include:
  - a) A brief discussion of hazards of radiation and radioactive materials;
  - b) Recognition of warning signs;
  - c) Areas from which such persons are restricted; and
  - d) Person(s) to contact in the event of incident or emergency.
4. All training shall be documented using the Training Record and Acknowledgment Form located in Appendix C, maintained on file by the Authorized User, and copies forwarded to EHSRM within 10 days of completion.

## **VIII. INSPECTIONS**

Authorized Users may be inspected for compliance at any time by either the Texas Department of State Health Services, the RSO, or EHSRM staff. The following information is intended to make the Authorized User aware of the inspection program and to provide general information on what is expected during inspections:

### **A. Inspections by the Texas Department of State Health Services**

1. Inspections conducted by TDSHS may include spot inspections of individual Authorized Users. Such inspections are typically scheduled by the state inspector with one-to-two-week prior notice.
2. The Authorized User is responsible for providing all required documents and should be present during the inspection.

### **B. Inspections by the RSO or EHSRM**

1. EHSRM inspections may include:
  - a) Review of training records;
  - b) Review of approved worker list;
  - c) Review of procedures;

- d) Review of registration authorizations and conditions;
  - e) Performance of radiation area surveys in restricted and unrestricted areas, as appropriate;
  - f) Review of equipment inventory;
  - g) Review of security procedures; and
  - h) Inspection of personal protective devices.
2. EHSRM reserves the right to conduct inspections with no advanced notice. However, routine inspections are normally scheduled in advance.

## IX. INCIDENTS AND EMERGENCIES

### A. General

Any accident, injury, or loss of control of a radiation source 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 equipment's radiation source and the magnitude of associated risks. Each user of radiation producing equipment should be familiar with the basic emergency responses listed below and methods for applying them in their work area.

In the event of an emergency involving radiation, contact the RSO. If a serious or life-threatening emergency exists, or for calls outside normal business hours (Mon.-Fri., 8-5) contact the University Police Department or 911. Emergency contact information is provided below.

### B. Emergency Contact Information

#### RADIATION EMERGENCY NOTIFICATION & ASSISTANCE:

The Texas Department of State Health Services Radiation Control Program has established a 24-HOUR RADIOLOGICAL EMERGENCY ASSISTANCE telephone number **(512) 458-7460**. This number shall be used for emergency assistance and reporting only. For routine business matters call (512) 834-6688.

**SFA Radiation Safety Officer: Greg Moore**                      **936-468-6034\***  
*\*(Dial the last four digits only if using a university telephone)*

**Ambulance; Fire Department**                                      **911\***  
*\*(Dial "9" first if using a university telephone)*

**University Police Department**                                      **936-468-2608\***  
*\*(Dial the last four digits only if using a university telephone)*

**Environmental Health, Safety,  
and Risk Management Department (EHSRM)**                      **936-468-4514\***  
*\*(Dial the last four digits only if using a university telephone)*

### **C. What Constitutes an Incident or Emergency?**

1. Loss or theft of any radiation producing equipment.
2. High or potentially high accidental radiation exposure to an individual or to a member of the public.
3. Deceptive or potentially deceptive exposure of a dosimeter.
4. Any personnel injuries which may involve radiation exposure.

## **X. RECORD KEEPING REQUIREMENTS**

All Authorized Users of radiation producing equipment on the SFA campus shall maintain the following records in a clear, concise, and orderly format and forward copies of all records to the EHSRM Department. Retention periods are included in parentheses.

1. Copy of the current radiation producing equipment registration issued by TDSHS (until superseded).
2. Current radiation survey (life of Registration).
3. Equipment calibrations (3 years).
4. Personnel records (1 year): worker/user lists and training records.
5. Operating and emergency procedures (current).
6. Procedure manuals (current).
7. Records of radiation safety training for each Authorized User (3 years).
8. In addition to maintaining duplicates of certain records, EHSRM shall maintain the following records, which are available for review during normal office hours.
  - a) Original copy of all equipment Registrations issued to SFA.
  - b) Copies of current applicable regulations.
  - c) Inspection reports and copies of all "Notices of Violation" issued by state or federal regulatory agencies and the SFA responses to those Notices.
  - d) Current version of all applicable procedure manuals.
  - e) Dosimetry records.
  - f) Survey instrument calibration records.

## **PART TWO: RADIOACTIVE MATERIALS PROCEDURES**

### **I. PURPOSE AND SCOPE**

The purpose of Part Two of this manual is to establish the requirements for the use of licensed radioactive materials at Stephen F. Austin State University (SFA), in any physical or chemical form. The provisions contained in Part Two do not apply to radiation producing equipment (x-ray machines, bone densitometers, etc.). Part One of the Radiation Safety Manual is dedicated to Radiation Producing Equipment.

**SFA currently does not have an active license for the use of radioactive materials at the University. The following procedures will apply in the event that SFA obtains a new license issued by the Texas Department of State Health Services (TDSHS) for the use of radioactive materials for teaching or research.**

### **II. RESPONSIBILITIES**

The responsibilities associated with the management and uses of radioactive materials at SFA are described in Part One: Radiation Producing Equipment Procedures, found on page 5.

### **III. LICENSING AND REGULATORY REQUIREMENTS**

#### **A. University License**

SFA does not currently hold an active license for the use of radioactive materials on campus or any other location within the jurisdiction of the University. Prior to initiating, ordering, or obtaining any radioactive material, SFA faculty or staff must first be granted approval by the SFA Radiation Safety Committee (RSC) and the Radiation Safety Officer (RSO), and obtain a Radioactive Materials License issued by TDSHS. Authorized Users will be responsible for all payments and fees associated with obtaining the license.

#### **B. Authorization to Use Radioactive Materials**

1. Any faculty or staff member at SFA who applies for a permit to use radioactive materials, and must be in position of authority over laboratory personnel and operations. An application form is provided in Appendix D of this manual, and also available on the EH SRM website at: <http://www.sfasu.edu/safety>.
2. Approval must be granted by the RSC and RSO prior to purchasing or using any radioactive material on the SFA campus.
3. The RSO or the RSC may at any time place additional conditions or restrictions on an Authorized User for reasons of safety and/or compliance.
4. Only work which is authorized under the applicable License may be performed.
5. The Permit may include restrictions or limits on:
  - a) radionuclide(s) authorized for possession/use.
  - b) activity per radionuclide.
  - c) chemical or physical form of each the radionuclide.
  - d) location of use and/or storage of radioactive materials.
  - e) types of experiments authorized.

6. Radioactive materials shall not be used in or on humans.
7. Radioactive materials shall not be released to the environment unless specifically authorized in writing by the RSC and RSO.

#### **IV. PROCUREMENT, TRANSFER, DISPOSAL, & INVENTORY OF RADIOACTIVE MATERIALS**

The receipt, use, storage, and disposal of radioactive materials must be tracked from initial receipt at SFA to final disposal, by using the Radioactive Materials Usage Sheet provided in Appendix E. Accurate inventories and thorough documentation are fundamental controls necessary for SFA to demonstrate compliance with State and Federal regulations.

##### **A. Procurement of Radionuclides**

Once a State License is obtained from TDSHS, each Authorized User is responsible for ordering radionuclides directly from the vendor. The following procedures should be followed when ordering radioactive materials:

1. Prior to ordering radionuclides, the Authorized User or a designee shall obtain RSO approval to place the order (by email, fax, or by purchase requisitions routed for approval by EHSRM).
2. Radioactive materials may not be purchased using a SFA P-Card. Purchases may be made with an approved purchase order only.
3. When placing orders, ensure that the “bill to” address is appropriate for the source of funds (never EHSRM).
4. Radioactive materials may be delivered only to destinations approved by EHSRM 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 SFA main campus.

1. All incoming shipments of licensed radioactive materials must be received, inspected, and documented on the Radioactive Materials Usage Sheet provided in Appendix E, (also available on the EHSRM website).
2. Radioactive materials shall be delivered directly to the laboratory where they will be used, not to departmental offices.
3. Deliveries shall only be made during normal business hours when an Authorized User is available to receive the shipment.

##### **C. Inventory of Radionuclides**

1. Each Authorized User shall maintain accurate inventory records at all times.
2. EHSRM will send a printout of the most recent radioactive material inventory on file to each Authorized User annually.
3. The Authorized User, or designee, shall physically locate each item on the inventory, sign and date the inventory, return the inventory bearing the original signature, and keep a copy for their records. Changes in inventory shall be documented and accompanied with supporting documentation showing the receipt of new material or those discarded as waste.

4. Discrepancies between the previous year's printed inventory from EHSRM and the actual materials on-hand shall be noted, explained in writing and supporting documentation, and returned to EHSRM with the inventory records.

#### **D. Transfer of Radioactive Materials**

“Transfer” of a radioactive material, as used in this section, does not include transfer of radioactive materials to EHSRM 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 Authorized User (department or laboratory location) at SFA to another.

1. Transfers must be documented on the Radiation Material Usage Sheet in Appendix E and the materials inventory should be updated for each lab or work area involved in the transfer.
2. Transfers require prior RSO approval. Forward copies of all related documents to EHSRM.

#### **E. Disposal of Radioactive Materials**

1. No Authorized User may dispose of radioactive materials except:
  - a) by transfer to EHSRM for off-site disposal, or
  - b) as specifically authorized by the RSO and RSC.
2. All Authorized Users are hereby authorized to wash contaminated glassware, lab coats, etc. and discharge the rinse water to the sanitary sewer system. No radioactive materials, including those in rinse water may be discharged into any drain which is not connected to a sanitary sewer system. A septic tank is not a sanitary sewer.
3. All radioactive waste containers (carboys, bags, trash cans, etc.) shall be conspicuously marked with the words “Hazardous Waste” or “Radioactive Waste” as well as the specific materials and chemicals which make up the waste. Radioactive waste held for off-site disposal shall be kept in a closed rigid container to prevent leakage, and must be kept in a secure area which is appropriately marked for radioactive materials.
4. Waste disposal procedures vary depending on the type of material, half-life, and physical state. Contact the RSO or EHSRM for assistance with proper waste disposal or to schedule a waste pickup.
5. See the SFA Hazardous Waste manual located on the EHSRM website at: [www.sfasu.edu/safety](http://www.sfasu.edu/safety) for more information on proper waste disposal.
6. Document approved disposal of radioactive materials on the Radiation Materials Usage Sheet provided in the Appendix E, and forward copies to EHSRM monthly.
7. Disposal documentation must be maintained on-file for 3 years after final disposal.

### **V. RADIATION EXPOSURE CONTROL**

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 long-term effects such as cancer in the exposed individual.

State and federal regulations have established a system of dose limitation and minimization described in 25 TAC 289.202. 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 further minimize radiation doses to individuals and to groups of individuals to the extent practical, 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 is Reasonably Achievable.

#### **A. Radiation Dose Limits**

1. Occupationally Dose Limits for Adults:
  - f) Total Effective Dose Equivalent (TEDE) - 5 rem/y (5,000 mrem/y)
  - g) Total Organ Dose Equivalent (TODE) - 50 rem/y (50,000 mrem/y)
  - h) Shallow Dose Equivalent (SDE) -50 rem/y (50,000 mrem/y)
  - i) Extremity Dose Equivalent -50 rem/y (50,000 mrem/y)
  - j) Lens (of Eye) Dose Equivalent (LDE) - 15 rem/y (15,000 mrem/y)
2. Dose to an Embryo/Fetus of a Declared Pregnant Woman (occupational exposure)
  - c) Total Effective Dose Equivalent (TEDE) - 500 mrem over entire pregnancy
  - d) TEDE should not vary substantially above 50 mrem in any month
3. Individual Members of the Public
  - c) 2 mrem in any one hour
  - d) Total Effective Dose Equivalent (TEDE) - 0.1 rem/y (100 mrem/y)

#### **B. Routes of Exposure and Means of Exposure Control**

Exposures may be received from radioactive materials which are external to the body (external exposure) or from radioactive materials which are inside the body (internal exposure) or both.

1. Control of External Exposure:

Common external exposure controls include the use of time, distance, and shielding to minimize radiation doses. In addition, doses may also be reduced by minimizing the amount of radioactive materials on-hand (e.g., procure only the amount needed) or by substituting for radioactive materials (e.g., use P-33 instead of P-32 or use nonradioactive tracer techniques).
2. Control of 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, and injection through wounds. To protect against these routes of intake, Authorized Users are expected to utilize good laboratory safety practices as identified in this manual. Of particular importance are the following:

  - a) Use of a properly functioning fume hood which is suitable for use of radioactive materials - particularly when using volatile radioactive compounds (those which could reasonably become airborne).
  - b) No eating, drinking, or applying cosmetics in a laboratory in which radioactive materials (other than sealed sources) are used or stored. This also includes smokeless tobacco and chewing gum. Furthermore, food, drinks, eating utensils, cups, drinking glasses, etc. shall not be used or stored in rooms or refrigerators where use of radioactive material is authorized. Refrigerators, microwave ovens, and ice machines in laboratories are not for personal use.
  - c) Wear protective clothing, including gloves and closed-toe shoes. Laboratory coats are required when using activities greater than 50 microcuries (remember to

protect legs by wearing leg coverings or a long lab coat). Lab coats and eye protection are recommended at any level.

## **VI. EMPLOYEE DOSE MONITORING**

Employee monitoring for radiation doses is done by dosimetry badge monitoring and analysis. The purpose of the radiation dosimetry program is to measure radiation dose equivalent received by occupationally exposed individuals at SFA. 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.

### **External Radiation Dosimetry**

1. Radiation dosimeters appropriate for the potential exposure will be issued and monitored by the EHSRM Department to the individual and shall be worn by SFA employees likely to receive, in one year, a dose in excess of 10% of the applicable dose limits.
2. The RSO and RSC shall determine the “likely to exceed 10%” status of an individual, the dosimeter type.
3. 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.
4. Radiation dosimeters shall not be deceptively exposed.
  - a) Dosimeters are issued to only one person. Dosimeters shall not be shared.
  - b) Dosimeters in storage and not being worn shall not be stored near sources of radiation.
  - c) Dosimeters should not be exposed to high heat, chemical or physical damage, or washed in a washing machine.
  - d) No person shall wear dosimeters issued by SFA while working for another employer or institution.
  - e) Authorized Users shall notify EHSRM if employees are concurrently working for another (non-SFA) employer and working with sources of ionizing radiation.
  - f) Dosimeters shall not be worn during personal medical or dental x-ray examinations.
  - g) Dosimeters shall not be worn after medical administration of radioactive materials (thyroid ablation therapy, cardiac stress tests, diagnostic nuclear medicine tests, etc.).
  - h) Authorized Users shall notify the RSO immediately upon learning of possible deceptive exposures of dosimeters.
  - i) Intentional deceptive exposures of dosimeters are forbidden and may result in enforcement actions.
  - j) Lost or damaged dosimeters shall be reported to the RSO as soon as possible.
5. Proper wearing of dosimeters:
  - a) Whole body dosimeters are the most common type of monitoring device worn by persons operating radiation producing equipment 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 the definition of “whole body” in Appendix A).

- b) Persons who wear a leaded apron should wear whole body dosimeters outside of any leaded apron. Those who perform diagnostic x-ray and/or fluoroscopy procedures should normally wear the dosimeter at the collar.
- c) Declared pregnant women, who wear dosimeters for fetal monitoring, shall wear the dosimeters on the abdomen. If a leaded apron is worn by the x-ray technician, the dosimeter should normally be placed on the abdomen, under the apron.
- d) Authorized Users or their designees shall collect and return used dosimeters to EHSRM promptly after receiving replacement dosimeters at the beginning of a new wear period.
- e) Any person who works with any source of radiation at SFA (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 the EHSRM Department upon request.
- f) All individuals issued personal dosimetry will receive annual reports indicating their exposure.
- g) Authorized Users shall be responsible for the costs associated with dosimetry services.

## **VII. RADIATION SURVEYS, POSTINGS, AND DETECTION EQUIPMENT**

Radiation surveys are conducted by monitoring the area outside and adjacent to a restricted radiation equipment room to ensure that no radiation is escaping the restricted area and potentially exposing other workers or the general public. Radiation 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 radiation meter or by placing a dosimeter in the area to monitor over a specific time period. The EHSRM Department and the Authorized User must work together to ensure safety in the workplace and to protect both the public and the environment from the harmful effects of radiation.

### **A. Types of Surveys**

1. Radiation surveys – may be performed to measure exposure or dose rates from sources of radiation which are in storage, in waste, or in use. Radiation surveys are required to be performed in:
  - a) Laboratories using 10 millicuries or more of photon or neutron emitting radionuclides or radioactive sources.
  - b) Laboratories using one or more of the radionuclides shown in step a) above when:
    - i. new and significantly higher activity sources are received,
    - ii. radioactive material storage areas are relocated,
    - iii. radioactive waste containers are relocated, and/or
    - iv. radioactivity levels in storage are changed significantly.
  - c) Radiation surveys shall be performed monthly and documented on the Radiation Survey Form located in Appendix F.
2. 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.

- a) Contamination surveys shall be performed monthly, and are necessary to demonstrate compliance with the regulations.
- b) Contamination surveys shall be performed and documented on the Radiation Survey Form located the Appendix F.
3. Airborne radioactivity surveys shall be performed by the RSO on an “as needed” or “on-request” basis.
4. Fume hood surveys (inspections) are required annually or after maintenance which could affect fume hood face velocity. Fume hood inspections are performed at least annually by EHSRM.

## **B. Area Limits**

Radiation levels must be maintained and limited as follows:

1. Less than 50 mrem in any one year in unrestricted areas ( $< 5.7 \mu\text{rem/hr}$ ) applies to long-term (typically greater than 8-hour) exposures.
2. In restricted areas, exposure rates should be kept ALARA (As Low As Reasonably Achievable). Generally, the goal should be to keep radiation levels less than 5 mrem per hour.
3. Contamination levels on laboratory surfaces (removable) as determined by either wipe survey or instrument survey shall be limited as follows:
  - a) No detectable contamination above background
  - b) The determination of “no detectable contamination above background” must be made with a detector which has been response checked within the past 12 months and which is suitable for measuring the type(s) of radiation expected.
  - c) If detectable contamination (above background) remains after decontamination efforts, contact the RSO for assistance.
4. Contamination levels on personnel or clothing - no detectable contamination above background.

## **C. Postings**

The following signs are required:

1. **“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.
2. Signs and postings should be removed when conditions no longer warrant that posting.
3. Signs and postings shall display the universal radiation symbol and be red, orange, or yellow in contrast to the surrounding environment.

## **D. Labeling**

**“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:

1. 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
2. Containers that are in transport and properly labeled for such.

## E. Radiation Detection Equipment

1. Each Authorized User must possess radiation detection equipment that is appropriate for detecting the types of radiations emitted by the radionuclides for which they are authorized.
  - a) For authorization to possess any quantity of H-3 (tritium) or quantities of C-14 of 250  $\mu\text{Ci}$  or less, Authorized Users 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.
  - b) For authorization to possess any other beta emitting radionuclide, for C-14 in quantities exceeding 250  $\mu\text{Ci}$ , and for any gamma emitting radionuclide, the Authorized User must possess a properly operating portable radiation detector appropriate for detecting those radiations.
    - i. A thin window Geiger-Mueller (GM) detector is normally the best choice for most alpha and beta emitting radionuclides.
    - ii. A portable scintillation detector is required for Authorized Users authorized to possess I-125 in activities greater than 1 mCi.
  - c) EXEMPTIONS - radiation detectors are not required for those who possess only:
    - i. Ni-63 sources in electron capture detector (ECD) cells used in gas chromatography.
    - ii. Uranium or thorium in compounds in total quantities of 3 kilograms (6.6 pounds) or less.
    - iii. Exceptions may be granted by the RSO on a case-by-case basis.
2. 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 a 3<sup>rd</sup> party vendor approved by EHSRM. Contact the RSO for assistance with calibration requirements.

## VIII. RADIOACTIVE MATERIAL SECURITY

### A. On-Campus Security

Authorized Users are responsible for securing radioactive materials from unauthorized removal or access at all times in accordance with 25 TAC §289.202(y). In an academic environment, meeting this requirement can be difficult. The following practices are generally acceptable. If other security measures are employed, Authorized Users should consult with RSC and EHSRM.

1. 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.
2. 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.
3. If the Authorized User chooses not to lock the laboratory doors or cannot be assured of adequate security when the laboratory is locked, the Authorized User 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.
4. It is acknowledged that the laboratory may be unoccupied for brief periods of time during which an individual may answer the telephone, get a drink, etc. These absences are allowed under the following instances:

- a) experiments-in-progress wherein the total activity is less than 2 millicuries; or
- b) radioactive waste containers in which the total activity present in that individual waste container is less than 5 millicuries; or
- c) foil or sealed sources which are installed in a fixed/non-portable instrument or device, e.g., Ni-63 sources in ECD cells installed in a gas chromatograph.

### **B. Off-Campus Security**

Security of radioactive materials used in field experiments shall be reviewed by the RSC and RSO on a case-by-case basis.

## **IX. TRAINING**

All individuals who work with or near licensed sources of radiation are required to complete radiation safety training. The depth of the training must be commensurate with the level of hazard to which the individual is exposed.

All training must be documented on the Training Record and Acknowledgement Form in Appendix C. No individual shall be allowed to work unsupervised with licensed sources of radiation until that person completes appropriate radiation safety training.

### **Basic Radiation Safety Training**

1. All individuals, including Authorized Users and student workers, who work with or are authorized to possess radioactive materials, are required to complete appropriate radiation safety training course(s) offered or approved by EHSRM.
2. Each Authorized User is responsible for providing and documenting laboratory-specific training, using the Training Record and Acknowledgement Form, to individuals (including students) who work with registered sources of radiation under the Authorized User's control. This training shall address, as applicable:
  - a) Area restrictions - where radioactive materials are used within the lab(s) and restrictions on that use;
  - b) Procedures for security;
  - c) Posting locations for required signs and notices;
  - d) Walk-through review of protocols involving radioactive materials; and
  - e) Special handling techniques which will minimize exposures.
3. Training for individuals, who may be in the vicinity of the laboratory or work area where radioactive materials are used shall include:
  - a) A brief discussion of hazards of radioactive materials;
  - b) Recognition of warning signs;
  - c) Areas from which such persons are restricted; and
  - d) Person(s) to contact in the event of incident or emergency.
4. All training shall be documented and maintained on file by the Authorized User, and copies of training records shall be forwarded to EHSRM within 10 days of completion.

## **X. TRANSPORTATION OF RADIOACTIVE MATERIALS**

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 any vehicle on public roadways (including campus streets) or by air, water, or rail. Personal vehicles shall **NOT** be used to transport radioactive materials. Radioactive materials which are hand carried or transferred on a moveable cart between laboratories or buildings on campus is not considered “in-transport”.

**Requirements for packaging, transporting, or receiving radioactive materials:**

1. 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 other EHSRM approved training organization.
2. Use the Non-Commercial Radioactive Material Shipment and Receipt Form in Appendix G to document the transport or receipt of radioactive materials.
3. Persons who are not properly trained and certified shall not be allowed to package, transport, or ship radioactive materials. Contact EHSRM for assistance.
4. At no time shall any Authorized User or designee carry radioactive material aboard a passenger-carrying aircraft or in their personal vehicle.

## **XI. INSPECTIONS**

Authorized Users may be inspected at any time by either the Texas Department of State Health Services, the RSO, or EHSRM staff. The following information is intended to provide general information on what is expected during inspections:

**A. Inspections by the Texas Department of State Health Services:**

1. Inspections conducted by TDSHS may include spot inspections of individual Authorized Users. Such inspections are typically scheduled with one to two weeks prior notice.
2. All required documents and the Authorized User should be present during the inspection.

**B. Inspections by the RSO or EHSRM:**

1. EHSRM inspections will be conducted at least annually and will include the following:
  - a) Performance of a contamination survey,
  - b) Survey instrument check,
  - c) Check on postings in laboratory,
  - d) Ensuring that work areas and waste containers are appropriately marked,
  - e) Review of radioactive material security,
  - f) Review of training records,
  - g) Review of worker list,
  - h) Review of procedures,
  - i) Review of License authorizations and conditions,
  - j) Performance of radiation area surveys in restricted and unrestricted areas, as appropriate for the radionuclides and activities present,
  - k) Review of material inventory, and
  - l) Review of survey records.

## **XII. INCIDENTS AND EMERGENCIES**

### **A. General**

Any accident, injury, or loss of control of a radiation source 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.

In the event of an emergency involving radiation, contact the RSO. If a serious or life-threatening emergency exists, or for calls outside normal business hours (Mon.-Fri., 8-5) contact the University Police Department or 911. Emergency contact information is provided below.

### **B. Emergency Contact Information**

#### **RADIATION EMERGENCY NOTIFICATIONS & ASSISTANCE:**

The Texas Department of State Health Services Radiation Control Program has established a 24-HOUR RADIOLOGICAL EMERGENCY ASSISTANCE telephone number **(512) 458-7460**. This number shall be used for emergency assistance reporting only. For routine business matters call (512) 834-6688.

**SFA Radiation Safety Officer: Greg Moore**                      **936-468-6034\***

*\*(Dial the last four digits only if using a university telephone)*

**Ambulance; Fire Department**                                      **911\***

*\*(Dial "9" first if using a university telephone)*

**University Police Department**                                      **936-468-2608\***

*\*(Dial the last four digits only if using a university telephone)*

**Environmental Health, Safety,  
and Risk Management Department (EHSRM)**                      **936-468-4514\***

*\*(Dial the last four digits only if using a university telephone)*

### **C. What Constitutes an Incident or Emergency?**

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



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

#### **D. Injuries Involving Contamination or Exposure to Radiation**

1. Provide first aid immediately for serious injuries.
2. Call 9-911 from a university telephone or 911 from a personal phone.
3. Notify EHSRM.
4. If possible, without doing harm to the victim, monitor the injured individual and remove contaminated clothing and gross personal contamination.
5. Provide a detailed written report to EHSRM within 5 working days.

#### **E. Decontamination of Personnel**

1. Remove and bag all contaminated clothing.
2. Skin contamination should be cleaned using mild soap and water. Use portable survey meter to monitor for remaining contamination. If not free of contamination, rewash and resurvey. Decontamination solutions which are formulated for use on skin may be used, if available.
3. Call EHSRM to report the incident even if the decontamination was successful.
4. Survey for contamination elsewhere on the body as well as on clothes, shoes, floor, door handles, telephone, etc. Document the surveys on the Radiation Survey Form in Appendix F.
5. If the contamination is in a wound (e.g., a cut from contaminated glassware) rinse the wound with copious quantities of water.
6. Write an account of the incident, signed by the Authorized User, and send a copy to EHSRM.

#### **F. Radioactive Spills or Releases**

Decontamination shall be the responsibility of the Authorized User or properly trained individual that caused the spill. 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 designee.

Appropriate protective clothing shall be worn during decontamination activities. Steps to respond to spill incidents are:

1. Stop work and confine the spill immediately using an absorbent, enclosure, etc. Call EHSRM immediately.
2. Warn others of the hazard and isolate the area.
3. Monitor personnel during and after cleanup for contamination.
4. Collect all used cleanup materials as radioactive waste. Remove and bag all contaminated clothing or cleanable items for removal by EHSRM.

5. Commence wipe surveys and decontamination. Ensure surveys of surrounding areas are performed to ensure that all contaminated areas are identified.
6. Prepare a written report on the incident and send a copy to EHSRM.

### **XIII. RECORD KEEPING REQUIREMENTS**

All Authorized Users of radiation producing equipment on the SFA campus shall maintain the following records in a clear, concise, and orderly format and forward copies of all records to the EHSRM Department. Retention periods are included in parentheses.

1. Copy of the current Radioactive Materials License issued by TDSHS (until superseded).
2. Transfer and disposal records for every licensed source of radiation (1 year after final disposal).
3. Copies of inventory records (1 year or until superseded).
4. Surveys (life of License).
  - a) contamination surveys
  - b) radiation field surveys in restricted areas
  - c) radiation field surveys in unrestricted areas
5. Survey instrument calibrations (3 years).
6. Personnel records – worker lists and training records (1 year).
7. Operating and emergency procedures (current).
8. Records of radiation safety training for each individual authorized to use radioactive materials (3 years).
9. In addition to maintaining duplicates of all records mentioned above, EHSRM shall maintain the following records which are available for review during normal office hours:
  - a) Original copy of all radioactive material licenses issued to SFA.
  - b) Copies of current applicable regulations.
  - c) Official inventory records.
  - d) Inspection reports and copies of all “Notices of Violation” issued by state or federal regulatory agencies and the SFA responses to those Notices.
  - e) Current version of all applicable procedure manuals.
  - f) Calculations and reports as required for compliance with the Clean Air Act for radionuclide releases from SFA facilities (as needed).
  - g) Dosimetry records.
  - h) Leak test results.
  - i) Survey instrument calibration records.

### **XIV. 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. The most common uses of sealed sources are in moisture gauges and electron capture detector (ECD) cells.

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.

Users authorized to possess sealed sources are required to:

1. Perform sealed source leak tests monthly.
2. Moisture/density gauges users shall create and maintain a use-log which identifies where a device is at any time (when it is not in storage) as well as identifying the person responsible for maintaining control of the gauge while it is in use.
3. Define a storage area which has adequate security.
4. Conduct or arrange for the RSO to conduct storage area surveys:
  - a) When initially establishing the storage location,
  - b) When changing a storage location,
  - c) When adding a gauge to a storage location, or
  - d) When the occupancy of the areas adjacent to the storage location are changed.
5. Ensure that only persons who have been properly trained may have access to or operate a moisture/density gauge or other device containing a sealed source.
6. Ensure that the moisture/density gauges and other source(s) are transported with adequate protection to prevent damage to the source in the event of an accident.

## APPENDIX A

### DEFINITIONS

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).

$$1 \text{ Ci} = 37,000,000,000 \text{ dps (} 3.7 \times 10^{10} \text{ dps)}$$

$$1 \text{ Ci} = 2,220,000,000,000 \text{ dpm (} 2.22 \times 10^{12} \text{ dpm)}$$

$$1 \text{ Bq} = 1 \text{ dps}$$

Adult means an individual 18 years or older.

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.

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 DAChours.

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 is 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 SFA faculty or staff member authorized by the SFA RSO to possess and/or use radiation producing equipment or radioactive material(s).

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 TDSHS.

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

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 ( $H_{E,50} = \sum W_{T,H_{T,50}}$ ).

Curie (Ci) means a unit of measurement of activity. One curie (Ci) is that quantity of radioactive material that decays at the rate of  $3.7 \times 10^{10}$  disintegrations per second (dps). Commonly used sub-multiples of the curie are the millicurie and the microcurie. One millicurie (mCi) =  $1 \times 10^{-3}$  curie =  $3.7 \times 10^7$  dps. One microcurie ( $\mu$ Ci.) =  $1 \times 10^{-6}$  curie =  $3.7 \times 10^4$  dps. One nanocurie (nCi) =  $1 \times 10^{-9}$  curie =  $3.7 \times 10^1$  dps. One picocurie (pCi) =  $1 \times 10^{-12}$  curie =  $3.7 \times 10^{-2}$  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 ( $1000 \text{ mg/cm}^2$ ).

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.  $1 \text{ Sv} = 100 \text{ rem}$ .

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 ( $H_E = \sum W_T H_T$ ).

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).  $1 \text{ R} = 2.58 \times 10^{-4} \text{ C/kg}$ .

Exposure rate means the exposure per unit of time, typically milliroentgen per hour (mR/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/cm<sup>2</sup>).

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).

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 SFA.

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, Radiation Control Program to an applicant who has met the requirements for licensing.

Licensed material means radioactive material received, possessed, used, or transferred under a license.

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.

Member of the public means any individual, except an individual who is performing assigned duties for an Authorized User involving exposure to sources of radiation.

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.

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

<u>Radiation</u>	<u>Quality Factor</u>
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 Producing Equipment means any device capable of producing ionizing radiation except those devices with radioactive material as the only source of radiation.

Radiation Safety Officer 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.

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 Authorized User 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  $2.58 \times 10^{-4}$  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/cm<sup>2</sup>) 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 an evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal, and/or presence of sources of radiation.

When appropriate, such evaluation includes, but is not limited to, tests, physical examination of location of materials and equipment, and 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.

$$\text{TEDE} = \text{DDE} + \text{CEDE}$$

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.

$$\text{TODE} = \text{DDE} + \text{CDE}$$

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





## APPENDIX B

### APPLICATION FOR USE OF RADIATION PRODUCING EQUIPMENT

The Environmental Health, Safety, and Risk Management Department (EHSRM) 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 – radioactive materials are licensed through this department under separate rules (see Part Two of this manual).

The primary Authorized User is the person who will be responsible for the safe use of the radiation producing equipment. EHSRM requires advanced notification of intentions to dispose of or transfer the equipment.

**Submit the completed form to EHSRM by campus mail (box 6113) or fax to: 468-7312.**

Please complete the following:

1. Name and position (professor, staff etc.) of applicant: \_\_\_\_\_
2. Department: \_\_\_\_\_
3. Building name and room number where the machine will be located: \_\_\_\_\_
4. Campus Mail Box #: \_\_\_\_\_
5. Lab and office telephone numbers: \_\_\_\_\_
6. Email address: \_\_\_\_\_
7. Type of device (e.g., analytical X-ray, diffraction X-ray, Densitometer): \_\_\_\_\_
8. Machine manufacturer: \_\_\_\_\_
9. Machine model number: \_\_\_\_\_
10. SFA inventory control tag number: \_\_\_\_\_
11. Machine serial number: \_\_\_\_\_
12. Maximum kVp of the device: \_\_\_\_\_
13. Maximum mA of the device: \_\_\_\_\_
14. Number of x-ray tubes (zero, one or two): \_\_\_\_\_
15. Indicate what interlocks or safety devices are engineered into the device. \_\_\_\_\_
16. Describe the intended use of the machine. (Student teaching/demonstration, analytical, research, diagnostic etc.): \_\_\_\_\_
17. Describe the training and experience of the individual in item one with regard to the use of this type of equipment. \_\_\_\_\_
18. Provide a sketch of the room or lab with equipment placement indicated. Indicate occupational uses of nearby areas. Attach the sketch on a separate page.
19. List names of others authorized to use this equipment. \_\_\_\_\_

Signature of Applicant: \_\_\_\_\_ Date: \_\_\_\_\_

RSO Approval: \_\_\_\_\_ Date: \_\_\_\_\_

Department Head Approval: \_\_\_\_\_ Date: \_\_\_\_\_



## APPENDIX C

### TRAINING RECORD AND ACKNOWLEDGEMENT FORM

This form is to be completed by each individual who will use radioactive material(s) and/or who will be monitored for radiation exposure.

**Submit the completed form to EHSRM by campus mail (box 6113) or fax to: 468-7312.**

1. Name: \_\_\_\_\_ Location of Laboratory: \_\_\_\_\_
2. Department: \_\_\_\_\_ Telephone: \_\_\_\_\_
3. S.S. No.: \_\_\_\_/\_\_\_\_/\_\_\_\_ Birthdate: \_\_\_\_/\_\_\_\_/\_\_\_\_ Film Badge No.: \_\_\_\_
4. Previous Employments Involving Exposure and Cumulative Dose Received: \_\_\_\_\_  
\_\_\_\_\_
5. Date of Training: \_\_\_\_\_
6. Type of training (topics covered): \_\_\_\_\_
7. Instructor Name: \_\_\_\_\_
8. Location of Training: \_\_\_\_\_
9. Duration: \_\_\_\_\_
10. Principles and Practices of Radiation Protection: \_\_\_\_\_  
\_\_\_\_\_
11. Measurement, Monitoring, Techniques, Instruments: \_\_\_\_\_  
\_\_\_\_\_
12. Experience Using Radiation Producing Equipment or Isotopes\*:
  - a. Type of Equipment Used: \_\_\_\_\_
  - b. Isotope \_\_\_\_\_ c. Max. Amt. (mCi) Used \_\_\_\_\_
  - d. Where Used \_\_\_\_\_ e. Duration of Use \_\_\_\_\_
13. I certify that the history in number 4 is correct to the best of my knowledge. I have received a copy and read the SFA Radiation Safety Manual and will abide by the regulations governing the use of radioisotopes and/or radiation producing equipment. I agree that under Texas law I will probably have no recourse against SFA for any personal injury or property damage resulting from my failure to comply with such regulations.  
  
Signature: \_\_\_\_\_ Date: \_\_\_\_\_

\* Documented evidence must be provided



## APPENDIX D

### APPLICATION TO USE RADIOACTIVE MATERIALS

The Environmental Health, Safety, and Risk Management Department (EHSRM) is required by state law to obtain a License for the use of radioactive materials used in teaching or research. Radiation producing equipment is registered through this department under separate rules (see Part One of this manual).

The primary Authorized User is the person who will be responsible for the safe use of the radioactive material(s). EHSRM requires advanced notification of intentions to dispose of or transfer radioactive materials.

**Submit the completed form to EHSRM by campus mail (box 6113) or fax to: 468-7312.**

Please complete the following:

1. Name and position (professor, staff etc.) of applicant: \_\_\_\_\_
2. Department: \_\_\_\_\_
3. Building and room number where the material will be used or stored: \_\_\_\_\_
4. Campus Mail Box #: \_\_\_\_\_
5. Lab and office telephone numbers: \_\_\_\_\_
6. Email address: \_\_\_\_\_
7. Isotope: \_\_\_\_\_ Chemical and Physical Form: \_\_\_\_\_

Maximum to be used in a single experiment: \_\_\_\_\_ [ ]  $\mu$ Ci or [ ] mCi

Maximum to be ordered per shipment: \_\_\_\_\_ [ ]  $\mu$ Ci or [ ] mCi

Estimated order per year: \_\_\_\_\_ [ ]  $\mu$ Ci or [ ] mCi

8. Brief title and objective of the study involved:  
\_\_\_\_\_  
\_\_\_\_\_
9. Method to be used. Use back of this sheet if necessary. A copy of procedure notes may be attached. If material is attached, please so indicate.  
\_\_\_\_\_
10. Room involved for each aspect of the work, including experiments, isotope storage, sample counting, "hot sinks", waste storage ( [ ] solid, [ ] liquid, [ ] gas, [ ] animal), animal housing, and monitoring of radioactivity. \_\_\_\_\_
11. Method of radioactive disposal.  
\_\_\_\_\_

Signature of Applicant: \_\_\_\_\_ Date: \_\_\_\_\_

RSO Approval: \_\_\_\_\_ Date: \_\_\_\_\_

Department Head Approval: \_\_\_\_\_ Date: \_\_\_\_\_



## APPENDIX E

### RADIOACTIVE MATERIALS USAGE SHEET

**ISOTOPE:** \_\_\_\_\_  
**RECEIVED DATE:** \_\_\_\_\_  
**LOT NO.:** \_\_\_\_\_  
**VENDOR:** \_\_\_\_\_  
**SPECIFIC ACTIVITY (mCi/mL):** \_\_\_\_\_  
**AMOUNT OF ISOTOPE (uCi):** \_\_\_\_\_  
**AMOUNT OF ISOTOPE (uL):** \_\_\_\_\_  
**PERSON LOGGING IN:** \_\_\_\_\_  
**LOCATION FOR STORAGE:** \_\_\_\_\_  
**TRANSFERRED TO:** \_\_\_\_\_  
**DATE OF TRANSFER:** \_\_\_\_\_  
**AMOUNT TRANSFERRED:** \_\_\_\_\_

DATE	UL USED	UCi USED	USAGE LOCATION	DISPOSAL LOCATION	USER NAME

**RECEIPT SURVEY**

**VISUAL:** \_\_\_\_\_  
**SHIELDED** (SURFACE): \_\_\_\_\_ mR/hr  
                   (1 METER): \_\_\_\_\_ mR/hr  
**UN-SHIELDED** (SURFACE): \_\_\_\_\_ mR/hr  
                   (1 METER): \_\_\_\_\_ mR/hr  
**SWIPE SURVEY:**



## APPENDIX F RADIATION SURVEY FORM

Authorized User: \_\_\_\_\_ Building/Room #: \_\_\_\_\_

Radionuclides Used: \_\_\_\_\_

### Survey Instrument Response

Make, Model, Serial No.	Background (cpm)	Check or Calibration Date
_____	_____	_____
_____	_____	_____
_____	_____	_____

### Contamination Survey Results

- Enter “work area” (be specific) and the name of the object or person surveyed.
- Mark “Yes” if contamination found to be greater than two times background. If so, be sure to document that the decontamination results are less than two times background or call the RSO for assistance.
- See attached printouts or additional information.

Survey Date	Location, Work Area, Object or Name of Person Surveyed	Contamination Found? Yes or No	Surveyed By:
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____



# APPENDIX G

## NON-COMMERICAL RADIOACTIVE MATERIAL SHIPMENT AND RECEIPT FORM

This form is to be filled out, and **sent to the RSO for completion**, prior to:

- (a) shipping any research or teaching-related radioactive material away from SFASU or
- (b) authorizing any outside individual or institution to send such material to SFASU.

An investigator at SFASU who uses this form must first have completed a Form No. 1 on the specific material in question and have had it approved by the RSO. This form also applies to materials involved in dealing with companies, when regular ordering and receipt procedures are not used.

Name and Address of Shipper:

Name and Address of Recipient:

License No. of Shipper: \_\_\_\_\_\*

License No. of Recipient: \_\_\_\_\_\*

1. SFASU Investigator No. : \_\_\_\_\_ SFASU PROTOCOL No. : \_\_\_\_\_

2. Isotope: \_\_\_\_\_ Chemical and Physical Form: \_\_\_\_\_

3. Quantity of Isotope (mCi): \_\_\_\_\_ Specific Activity: \_\_\_\_\_

4. Radiation Levels: At Surface: \_\_\_\_\_\*

At 1 Meter: \_\_\_\_\_\*

5. Carrier: \_\_\_\_\_ Transportation Index: \_\_\_\_\_

6. Shipping Papers Complete? [ ] YES\* / [ ] Not Applicable\*

7. Labeling Complete? [ ] Yes\* / [ ] Not Applicable\*

8. Institutional Approval: \_\_\_\_\_ (RSO) Date: \_\_\_\_\_

\_\_\_\_\_

Chairman RSO: \_\_\_\_\_ Date: \_\_\_\_\_

\_\_\_\_\_

\*. Items to be completed by the Radiation Safety Officer (RSO)