Kennesaw State University (KSU) is committed to providing and maintaining safe teaching, learning, living, and working environments for all members of its community. This commitment includes ensuring the proper storage, use, transfer and disposal of radioactive materials, and the minimization of injuries and illnesses associated with exposure to ionizing radiation. This will be accomplished through training and education of personnel in radiation safety and the use of administrative controls, engineering controls, safe work practices, and personal protective equipment (PPE). For determination of its effectiveness and for any necessary amendments, this Radiation Safety Program will be re-evaluated at least annually.

While this program addresses hazards associated with the use of radioactive materials, any hazardous conditions encountered that are not addressed by this document should be reported to the Department of Environmental Health and Safety (EHS) for investigation.

1. Purpose

The Nuclear Regulatory Commission (NRC) and the Georgia Department of Natural Resources (GADNR) both regulate the storage, use, transfer, disposal of materials, or the use of machinery that produces ionizing radiation. Under 10 CFR 20 and Georgia Rules and Regulations for Radioactive Materials (OCGA 391-3-17), provisions must be made to ensure that all doses of ionizing radiation are maintained "as low as reasonably achievable (ALARA)." The purpose of the Radiation Safety Program is to minimize potential exposures of all KSU employees and students to ionize radiation by incorporating the ALARA principle through the implementation of administrative and engineering controls, safe work practices, and the use of PPE. The requirements outlined in this document shall be in accordance with all Federal and State regulations governing the use of ionizing radiation, the requirements prescribed in the Radioactive Materials License, and with the processes and procedures approved by the KSU Radiation Safety Committee (RSC) and the Radiation Safety Officer (RSO).

2. Scope

The Radiation Safety Program applies to the use of all materials that emit ionizing radiation (e.g. – radioisotopes, radioactive sealed sources, button sources, machines that emit/produce ionizing radiation, etc.), and to all KSU employees and students who may come in contact or work with these materials.

3. Definitions

Activity	The rate of disintegration or "decay" of radioactive material (USNRC, 2017).

ALARA	Acronym meaning "As Low As Reasonably Achievable"
Background Radiation	Radiation from cosmic sources; naturally occurring radioactive material, including radon (except as a decay product of source or special nuclear material); and global fallout as it exists in the environment from the testing of nuclear explosive devices or from past nuclear accidents such as Chernobyl that contribute to background radiation and are not under the control of the licensee (USNRC, 2017).
Ionizing Radiation	A form of radiation, which includes alpha particles, beta particles, gamma rays, x-rays, neutrons, high-speed electrons, high-speed protons, and other particles capable of producing ions. Compared to non-ionizing radiation, such as radio- or microwaves, or visible, infrared, or ultraviolet light, ionizing radiation is considerably more energetic. When ionizing radiation passes through material such as air, water, or living tissue, it deposits enough energy to produce ions by breaking molecular bonds and displace (or remove) electrons from atoms or molecules. This electron displacement may lead to changes in living cells. Given this ability, ionizing radiation has several beneficial uses, including treating cancer or sterilizing medical equipment. However, ionizing radiation is potentially harmful if not used correctly, and high doses may result in severe skin or tissue damage (USNRC, 2017).
Machine Produced Radiation	Ionizing radiation or nuclear particles produced by any machine or device (e.g. – X-Ray machines, scanners, particle accelerators, etc.) under normal operating conditions.
Radiation	For the purposes of this document, the term "radiation" shall refer to "ionizing radiation."
Radioactive material (RAM)	Any material (i.e. – solid, liquid, or gas) that emits ionizing radiation in the form of alpha or beta particles, gamma rays, or neutrons.

4. Ionizing vs. Non-ionizing Radiation

Ionizing radiation is defined by the US Nuclear Regulatory Commission as forms of radiation, which include alpha particles, beta particles, gamma rays, x-rays, neutrons, high-speed electrons, high-speed protons, and other particles capable of producing ions. When ionizing radiation passes through material such as air, water, or living tissue, it deposits enough energy to produce ions by

breaking molecular bonds and displacing (or remove) electrons from atoms or molecules. This displacement in electrons can lead to changes in living cells, which can be therapeutic in certain applications, but can also be harmful if not utilized correctly. In high doses, ionizing radiation can cause severe damage to skin and tissues.

Non-ionizing radiation exists in several forms, including microwave radiation, infrared radiation, ultraviolet radiation, radio waves, and lasers. In comparison, non-ionizing radiation is not capable of producing ions, as it is less energetic than ionizing radiation. It lacks the energy needed to remove electrons from atoms or molecules. Non-ionizing radiation produces its effects through heating, which can also be harmful in high doses or if misapplied.

For the purposes of this document, the terms "radioisotope," "radiation," and "radioactive material" will be used when referring to ionizing radiation. Guidance for working with forms of non-ionizing radiation will be provided in separate guidelines.

5. General Radioactive Materials Use Requirements

A. General Radiation Safety Policy

All faculty, staff, and students who work with radioactive materials or machines that produce ionizing radiation must comply with the rules outlined in this document. All uses of radioactive material must be conducted in accordance with the State of Georgia Rules and Regulations for Radioactive Materials (OCGA 391-3-17), the KSU Radioactive Materials License, this document, and all written procedures applicable to specific areas. All uses of radiation producing machines (RPM) must be conducted in accordance with State of Georgia Rules and Regulations for X-Rays (OCGA 111-8-90), this document, and all written procedures applicable to specific areas.

B. ALARA Principle

The ALARA principle, as defined by the NRC, seeks to make every reasonable effort to maintain exposures to ionizing radiation as far below the dose limits as is practical. This radiation protection principle is based on a conservative dose–effect estimate called the "linear hypothesis," which states that any radiation dose, no matter how small, may have some adverse effect. It further assumes that in the absence of ionizing radiation, the risk of developing cancer or genetic effects already exists, but exposure to ionizing radiation in any dose would only increase the risk.

It is the goal of KSU to maintain all exposures **A**s **L**ow **A**s **R**easonably **A**chievable (ALARA) through the implementation of basic radiation protection principles. This principle shall be applied to all operations that use radioactive materials at KSU.

6. Kennesaw State University Roles and Responsibilities

A. Office of Research

- Establish a Radiation Safety Committee, as required under the State of Georgia Rules and Regulations for Radioactive Materials (OCGA 391-3-17) for the issuance and maintenance of the KSU Radioactive materials license.

- Support the development of the Radiation Safety Program and all its components, the enforcement of the terms of the radioactive materials license, and of all federal and state regulations.
- Provide financial support for the issuance and maintenance of the radioactive materials license.

B. Radiation Safety Committee

The establishment of an RSC is a requirement under State of Georgia Rules and Regulations for Radioactive Materials (OCGA 391-3-17) for the issuance and maintenance of the KSU Radioactive materials license.

1. Membership

Membership of the Committee must include the RSO, faculty who are knowledgeable in the use of ionizing and non-ionizing radiation sources, and senior administrative officers of the University, including a designated management representative of the Office of Research, who is neither a user nor the RSO. Membership may also include EHS professionals or qualified community members from other Universities and/or departments where radiation is used.

The committee must be a group comprised of a majority of faculty and staff who have training and experience working with radioactive materials and/or training and experience with radiation safety and protection measures.

The Radiation Safety Officer (RSO) will be a member by default.

Representation shall be determined by current members of the RSC, who will suggest the appointment of knowledgeable users from the research and academic community, and formally appointed by the Vice President for Research.

The designated management representative of the Office of Research, and the designated management representative of the Office of Research, members will be appointed for two- or three years with staggered appointments.

2. Responsibilities

The RSC will be responsible for overseeing the safe handling and use of radioactive materials at KSU by reviewing and approving/disapproving the following:

- Faculty or staff who will be designated as authorized users
- New applications submitted by faculty or staff to be designated as authorized users of radioactive materials or take possession of radiation producing machines
- Proposed amendments to existing RAM authorizations
- Proposed amendments to existing user protocols
- Proposed changes to facilities or work areas where RAM is used

The RSC will review all reportable incidents involving radioactive materials (e.g. – injuries, overexposure, etc.).

The RSC will conduct an annual review of all Radiation Safety Program documents to ensure that KSU's radiation program complies with all applicable regulations.

3. Authority

The RSC, supported by the VPR and the Deans of the affected Colleges, is authorized to implement additional radiation safety measures related to the use of radioactive materials or radiation producing machines/devices, or suspend the use thereof, if current safety practices are deemed insufficient.

C. Director of Environmental Health and Safety

- Designate a Radiation Safety Officer (RSO), as prescribed by 10 CFR 20 and OCGA 391-3-17.
- In collaboration with the RSC, will review and approve the Radiation Safety Program and any amendments made by the RSO.
- Support enforcement of the elements of the Radiation Safety Program by the RSO and the RSC.
- Support all efforts of the RSO to ensure proper use of radioactive materials from cradle to grave (i.e. – receipt, handling, use, storage, and disposal).

D. Radiation Safety Officer

The appointment of a Radiation Safety Officer (RSO) is a requirement under State of Georgia Rule 391-3-17 for the issuance and maintenance of the KSU Radioactive materials license. The RSO will be designated by the Director of Environmental Health and Safety (EHS) and appointed by the KSU President. The RSO must be qualified through education, training, and experience to provide guidance in the safe handling, use, storage, and disposal of radioactive materials.

1. Responsibilities

The RSO will be responsible for the daily oversight of the Radiation Safety Program, and will perform duties including (but not limited to) the following:

- Implement and manage a radiation protection program to provide guidance for the safe handling, use, storage, and disposal of radioactive materials and radiation producing machines.
- Ensure that possession, use, and storage of radioactive materials are in accordance with the limits outlined in the KSU radioactive materials license and State of Georgia Rules and Regulations for Radioactive Materials (OCGA 391-3-17).
- Ensure that faculty, staff, and students that will work with radioactive materials complete the appropriate radiation safety training.
- Implement and manage a radiation survey process as necessary for all areas on KSU's campuses where radioactive materials are handled, used, and stored.
- Maintain documentation by measurement or calculation that provides evidence that individuals are not likely to exceed 10% of their allowable exposure limits or provide dosimeters to monitor exposure.

- Implement and manage a personnel monitoring program to ensure that dosimeters are issued to personnel as needed, that the dosimeters are used, stored, and exchanged appropriately, and that monitoring records are maintained appropriately.
- Develop an inspection/audit program to address all radiation work areas. The inspections will include a review of all permit documentation, training records, RAM inventory, surveys of the work areas and the equipment used, and wipe testing documentation.
- Prescribe corrective actions based on the findings in the inspections/audits and generate and distribute inspection reports to authorized users.
- Make recommendations regarding the need for additional safety measures to the RSC as appropriate.
- Maintain the RAM license, and suggest necessary amendments/changes, or renewal as needed.
- Oversee the procurement, receipt, and delivery of all radioactive materials.
- Ensure that all transport of radioactive materials is done in accordance with all applicable Department of Transportation (DOT) requirements.
- Ensure that all radioactive materials are properly secured when not in use.
- Provide oversight into the disposal of all radioactive materials, including recordkeeping and effluent monitoring as needed.
- Maintain an inventory of all radioactive materials and radiation producing machines on KSU's campuses.
- Ensure that the inventory is maintained within the limits prescribed in the RAM license for all radioactive materials.
- Maintain all records of inspections, surveys, personnel training records, and personnel dosimetry reports as appropriate to remain in compliance with all Federal and State regulations.
- Review all personnel exposure data at least quarterly (as applicable) to ensure that all personnel exposure is maintained ALARA.
- The RSO will ensure that all radiation work areas are secure and properly marked as to prevent unauthorized entry and/or use of radioactive materials.
- Notify the proper authorities of reportable incidents regarding radioactive materials such as loss or theft, fire, or damage.
- Review the Radiation Safety Program and associated documents at least annually to ensure proper measures are being taken to ensure exposure are ALARA and program gaps are identified.

4. Authority

The RSO may review all protocols, experiments, and processes that use radioactive materials to recommend changes in practices and procedures if there are safety issues to the RSC.

The RSO, in conjunction with the RSC, may interrupt or suspend any activity that involves the use of radioactive materials if the activity is deemed to be unsafe, contrary to the terms of the RAM license, or in violation of federal or state regulations.

The RSO may make minor changes or amendments to internal radiation safety forms, guidance documents, and or procedures as needed.

The RSO may delegate certain tasks to another individual, if the individual has been trained and has demonstrated proficiency in the tasks delegated.

7. End-User Roles and Responsibilities

A. Directors, Supervisors, and Managers

Directors, supervisors, and managers must be aware of the use of radioactive materials, or the use of radiation producing equipment in their units/departments and must facilitate the safe use of these materials.

They must be aware of all the necessary training, storage, and use requirements for the users of radioactive materials or radiation producing equipment.

They must inform the RSO regarding certain actions or changes in protocol within their units/departments. Examples of actions that would require informing the Radiation Safety Officer include:

- Hiring researchers who will need to use radioactive materials in their studies.
- Whenever radiation permit holders, authorized users, or radiation workers leave KSU.
- Purchasing of new radiation producing equipment, or disposal of old radiation producing equipment.
- Making changes to areas where radioactive materials or radiation producing equipment is used.
- Providing support to the RSO regarding the enforcement of the Radiation Safety Program.

B. RAM Authorized Users

Researchers or staff members who intend to use radioactive materials in research or academics must first be granted the status of an Authorized User by the RSC.

1. Becoming an Authorized User

A candidate must complete all required training (i.e. – laboratory safety training, radiation safety training, etc.).

A candidate must complete the RAM permit application, which includes providing written protocols for the use of RAM.

The laboratory/facility where the candidate will use the RAM or a radiation producing machine will need to be inspected for adequacy based on the following (not limited to) criteria:

- Type of RAM that will be used in the RAM work area

- Location in relation to other areas (e.g. – classrooms, offices, other labs, etc.)
- Availability of shielding
- Availability of detection instruments
- Security of facilities

The application must be reviewed and approved by the RSC.

The candidate must receive the approved permit in writing from the RSC.

5. Responsibilities

- Adhere to all requirements set forth in this document.
- Ensure that any individual who works under him/her as a radiation worker adheres to all requirements set forth in this document.
- Ensure that all individuals who work under his/her supervision as a radiation worker complete all required training, and complete lab-specific training regarding the use of radioactive materials.
- Notify the RSO of any intent to order, purchase receive or transfer any radioactive material/radiation producing machine prior to doing so.
- Report all RAM related incidents, accidents, injuries, or suspected injuries to EHS. This includes completing an Employee Accident/Injury Report, or the Student Report of Health and Safety Incident form.

C. Radiation Workers

An individual who would like to work with radiation under the supervision of a RAM Authorized User must acquire status as a radiation worker.

1. Becoming a Radiation Worker

A candidate must complete all required training (i.e. – laboratory safety training, radiation safety training, etc.)

A candidate must be approved to become a radiation worker by the authorized user.

6. Responsibilities

- Adhere to all requirements set forth in this document.
- Complete all required training, and complete lab-specific training regarding the use of radioactive materials.
- Notify the RSO of any intent to order, purchase receive or transfer any radioactive material/radiation producing machine prior to doing so.
- Report all RAM related incidents, accidents, injuries, or suspected injuries to her/his PI, supervisor, director, or lab manager, and to EHS. This includes completing an Employee Accident/Injury Report, or the Student Report of Health and Safety Incident form.

8. Availability

This Radiation Safety Program document will be available on the KSU Environmental Health and Safety website (https://ehs.kennesaw.edu/). Licenses, permits, manifests, and all other documents related to the use of radioactive materials will be maintained within the EHS Department.

9. Radiation Exposure

A. Annual Exposure Limits – Radiation Workers

In accordance with Georgia Rules and Regulations for Radioactive Materials (OCGA 391-3-17), there are limits to radiation exposure for workers as well as members of the general public. The annual exposure limits for adult workers can be found in Table 1 below. If any worker exceeds the annual limit, that worker will be prohibited from working with or around radioactive materials for the remainder of the current (calendar) year.

Table 1: Annual Exposure Limits for Adult Radiation Workers

Occupational Exposure Limits for Radioactivity			
	Annual Limits	**Quarterly Limits**	**Quarterly Limits (X-Ray**
Whole Body	5 rem (0.05 Sieverts)	1250 mrem (12.5 mSv)	1 ¼ rem (3 rem allowed if 5 rem/year not exceeded)
Lens of the Eye	15 rem (0.15 Sieverts)	3750 mrem (37.5 mSv)	1 ¼ rem (3 rem allowed if 5 rem/year not exceeded)
Skin or Extremities	50 rem (0.5 Sieverts)	12500 mrem (125 mSv)	7 ½ rem
Fetus (if pregnant)	0.5 rem (5.0 millisieverts) for the entire term of pregnancy	N/A	Not to exceed 0.05 rem per month, 0.5 rem (5.0 mSv) during entire pregnancy after declaration

**Annual exposure limits for minors are 10% of the corresponding adult limits.*

B. Exposure Monitoring

Upon the authorization of radiation workers to work with radioactive materials, the RSO will make assessments regarding anticipated exposures of each radiation worker, either by calculations or measurements, to determine whether exposure monitoring is necessary. Exposure to ionizing radiation can be measured using "dosimeters" or "film badges." In accordance with Federal and State regulations, a badge must be assigned to any individual who is likely to be exposed to radiation levels more than ten percent of any annual limit. Badges are assigned to each individual radiation worker under unique identification numbers. These

badges are worn on the part(s) of the body that are most likely to get the greatest amount of exposure while working with or around radiation. Once the badges are worn for a specific period (e.g., monthly, quarterly, etc.), they are sent to the assigning vendor for processing. After processing, the vendor will provide exposure reports for the assigned badges. The amount of exposure will be reported in units of millirem (mrem).

C. How Badging Works

If badges must be assigned to personnel for exposure monitoring, there are several measures that must be taken to ensure that personnel monitoring and processing of the badges are done correctly:

- A control badge, or a badge that will be used to measure background radiation, will be issued to establish a baseline measurement.
- The control badge must be kept in a low radiation area where only background radiation can be measured. They must also be returned to the vendor for processing along with the badges assigned to the radiation workers for that area.
- Personnel who have been assigned badges must wear them in the lab only.
- Badges must be worn on the part of the body that is closest to the sources of radiation that the worker will be working with.
- For operators of radiation producing machines, a single badge must be worn unshielded on the collar or waist area. If a lead apron is worn, it must be worn on the outside of the apron at the collar. Assigned dose to Whole Body (WB) is 0.3 times the collar badge reading.
- Ring badges may be assigned for measuring exposures to extremities. If assigned, they must be worn so that the label is facing inward towards the palm of the hand, and under gloves to avoid being contaminated.
- Fetal monitors will be assigned for any worker who has declared pregnancy. Fetal monitors must be worn at the abdomen, and under protective lead shielding, if applicable.
- When not being worn, badges must be stored away from radiation sources.
- Badges must be worn only by the individual to whom they were assigned. They must not be shared or worn by another individual.
- At the end of the monitoring period, badges will be collected by the RSO or a designer. They can also be sent via interoffice mail to the EHS department. The badges will then be sent to the vendor for analysis.
- If a badge is lost, it must be reported to the RSO immediately so that a replacement can be assigned. Exposure for the period will need to be estimated based on the amount of radiation work that has been done by the worker from the time the badge was issued to the time it was lost.

Dosimetry badges can also be used to monitor the radiation exposure levels in areas where radioactive materials are stored (e.g., radioactive waste facilities, sealed source storage, etc.) or where radiation producing equipment is installed and used (e.g., x-ray facilities).

- In this application, a whole-body badge would be installed in the general area(s) where the radiation exposure is likely to take place.

- As with monitoring personnel, a control badge would also need to be kept in an area where only background radiation is detectable.
- At the end of the monitoring period, both the area monitor and the control badge are sent to the vendor for analysis.

D. Investigation of High-Level Exposures/Notifications

For individuals who have been assigned badges, exposure reports will be evaluated on a quarterly basis to identify those individuals who are most at risk for exceeding the annual exposure limits. These evaluations will be conducted in commitment to the ALARA principle, to keep all exposures as low as reasonably achievable. ALARA Levels (Level I and Level II) have been established in Table 2 below. These levels will determine when the point at which additional radiation protection measures need to be taken.

ALARA Investigational Levels				
	Annual Limits	**Goal (10% of Annual Limit)**	**ALARA I (Quarterly)**	**ALARA II (Quarterly)**
Whole Body	5,000 mrem	500 mrem	125 mrem	375 mrem
Lens of the Eye	15,000 mrem	1,500 mrem	375 mrem	1,125 mrem
Skin or Extremities	50,000 mrem	5,000 mrem	1,250 mrem	3,750 mrem
Fetus (if pregnant)	500 mrem/term	50 mrem/term	10 mrem	20 mrem

The goal of the ALARA program is to maintain all exposure to within 10 percent of the annual limits. If an individual reaches ALARA Level I, no further action is necessary. However, when an individual reaches ALARA Level II, the individual will be notified in writing, and the RSO will investigate to determine whether alternative or additional measures should be taken to reduce exposure.

E. Annual Exposure Limits – Non-Radiation Workers

Non-radiation workers are those individuals who do not work with radiation as part of their normal job duties at KSU. The exposure of these individuals to radiation must not exceed 0.1 rem, or 100 millirem (mrem) per year. This limit does not include exposures not related to work such as background radiation, radiation doses received during medical procedures or from exposures to people who have received radioactive treatments and have been released, from voluntary participation in research programs, or from sewer disposal. KSU, with commitment to the ALARA principle, will employ measures to minimize such exposures including but not limited to conducting contamination surveys to keep surfaces free of contamination, taking measurements of radiation levels, posting notices to indicate restricted areas, and establishing safety procedures for the safe procurement, storage, use, and proper disposal of radioactive materials.

Any non-radiation worker who is concerned about potential exposure to radiation should contact the RSO for guidance. The RSO can conduct a hazard assessment to determine the level of exposure, if any, and if necessary, can conduct temporary personnel monitoring via badging, or area monitoring via area dosimeters.

F. Pregnant Radiation Workers

KSU employees who work with radiation, or machines that produce radiation have the option of notifying the RSO of any suspected or confirmed pregnancies and are encouraged to do so in writing as soon as possible. The RSO will collaborate with the employee and her supervisor to properly monitor her radiation exposure during the pregnancy, and to implement any additional radiation protection measures to keep exposures within the annual limits prescribed by the State. The following steps will need to be taken for a suspected or confirmed pregnancy:

- The employee, if she chooses to declare pregnancy, should do so as soon as her pregnancy is confirmed. The declaration must be in writing to her supervisor and the RSO using the **Declaration of Pregnancy for Radiation Workers**, which will include the approximate date of conception.
- The RSO will determine what additional restrictions, if any, must be applied based on evaluation of her radiation exposure history.
- Any additional restrictions will be documented in writing and discussed with the employee and her supervisor.
- A copy of the document "**Instruction Concerning Prenatal Radiation Exposure**" will be provided to the declared pregnant employee as required by Federal and State regulations.
- The declared pregnant employee and her supervisor will sign a written statement indicating that they have received all necessary information.
- A fetal badge, which will be worn at the waist, will be assigned to the pregnant employee in addition to the badge(s) that she has already been assigned. If a protective lead apron is worn, the badge must be worn under the lead apron.

A pregnant radiation worker can seek consultation from the RSO related to radiation exposure without officially declaring pregnancy.

10. Training

Radiation safety training is provided to all KSU employees who work with radioactive materials. All personnel who plan to work with radioactive materials or radiation producing equipment must complete the required training prior to beginning work. Training will include material prescribed by state and federal regulations, content based on the job function, as well as topics identified by the department in which they work, and the RSC. There are three types of training courses based on job function: awareness training, training for laboratory workers, and training for working with radiation producing machines.

Training can be completed online, in a classroom setting, or a combination of both. Training completion records shall be documented and retained by EHS.

A. Radiation Safety Awareness Training

Awareness training shall be completed by workers who may work in areas where radiation is used, but do not work directly with radiation. Training for these workers will include the following topics:

- Potential hazards related to working with radiation in areas where radiation is used.
- Posting requirements of areas where radiation and/or radioactive material is used and/or stored.
- Basic radiation protection measures, including the concepts of time, distance, and shielding.

1. Completing Initial Training

Radiation Safety awareness training is available online via OwlTrain and can be assigned through EHS.

2. Refresher Training

Refresher training may need to be completed whenever an employee's duties change significantly, or if there is a change in regulatory requirements.

B. Radiation Training Requirements for Laboratory Workers

Training for personnel who work with radiation in laboratories will include (not limited to) the following topics:

- Atomic structures
- Alpha, beta, and gamma radiation
- Units of radioactivity
- Radioactive decay
- Biological effects of radiation
- Background radiation
- ALARA principle
- Radiation Protection principles
- Contamination surveys
- Radiation inventory
- Recordkeeping
- Personal protective equipment (PPE)
- Waste disposal
- Occupational dose limits and dosimetry
- Policy on radiation and pregnancy
- Purchase, receipt, and storage of radioactive material
- Instrumentation
- Spill/contamination procedures
- Emergency response

1. Completing Initial Training

Radiation Safety Training for Laboratory workers, which is offered in two parts:

- Part 1 is completed online via OwlTrain and must be completed prior to completing Part 2.
- Part 2 must be completed in a classroom setting and will include additional radiation topics and a hands-on element. This portion of the training must be scheduled with the RSO.

Both portions of the initial training must be completed prior to working with radioactive materials in the laboratory. If you must use radiation for work prior to completing the second part, the online portion must be completed, with the second portion being scheduled.

7. Refresher Training

Radiation Safety refresher training must be completed by laboratory workers at least every 3 years. Refresher training can be completed in several ways, and are as follows:

- Completing the initial training (both Parts 1 & 2)
- Completing the online portion only (Part 1)
- Completing the classroom portion only (Part 2)

Refresher training may be required sooner than three years at the discretion of the RSO and/or the RSC as part of corrective actions based on observations and/or inspection findings.

C. Training Requirements for X-Ray Machine Operators

State of Georgia regulations require operators of radiation-producing machinery to undergo at least a minimum of training. For patient and veterinary use, the requirement is 6 hours of radiation safety training prior to use of x-ray machines on patients. Similar requirements exist for other uses of x-ray – producing machines such as x-ray crystallography machines and DEXA units.

D. Training Content

Training for operators and support staff will include the following topics pertinent to their specific job function:

- Applicable regulations
- Operator responsibilities
- Potential radiation hazards in work areas
- Risk estimates, including comparison with other health risks.
- Basic radiation biology
- Steps to minimize exposure to patients & staff.
- Patient safety
- Radiation effects on skin
- Pregnant patient precautions

- Recording exposure information
- Reporting high or accidental exposures
- Proper use of personnel dosimetry
- Department-specific work rules
- Procedure risks

E. Access to Training

Training for the use of machines that produce radiation should be offered and scheduled through university departments and may require an outside vendor. Training records should be maintained by each department.

F. Retraining Frequency

Retraining will be conducted whenever there is a significant change in duties or regulations.

11. General Radiation Safety Rules and Considerations

The use of radioactive materials in research and teaching laboratories has the potential to cause health hazards to faculty, students and staff who work with or around the materials. Therefore, some general considerations must be made when working with radioactive materials.

A. Exposure Control

The following measures must be considered for the protection of employees and students from radiation exposure hazards, or those that may produce adverse effects on extremities or at surface level:

- Time – reducing the amount of time spent working with or being around ionizing radiation.
- Distance – increasing the distance between the source of the ionizing radiation and the worker. This method will reduce the dose by the square of the distance from the source.
- Shielding – placing an appropriate shielding material between the source of the ionizing radiation and the worker. Shielding materials must be available for specific isotopes used in the lab. The use of lead shielding is recommended for gamma emitters. Plexiglas shielding is recommended for high energy beta emitters.
- Monitoring devices should always be worn in areas where radiation is used and/or stored, if prescribed by the RSO.
- No one must obtain, store, or use radioactive materials unless authorized by the RSC or under the permission of an authorized user.

B. Contamination Control

The following measures must be considered to minimize the contamination of surfaces in the lab, or contamination of personnel during use of radioactive materials:

- All work surfaces where radioactive materials are used must be covered with absorbent paper. Absorbent paper must be checked for contamination after each use. Work with large volumes of radioactive material must be done using secondary containment (e.g., enclosed bin, tray, etc.).

- Personnel must always wear a lab coat or other protective clothing, disposable gloves, close-toed shoes, and eye protection when using radioactive materials.
- PPE such as gloves and lab coats should never be worn outside of the laboratory.
- Personnel should immediately wash his/her hands after removing gloves.
    - Never eat, drink, smoke, or apply cosmetics in areas where radioactive materials are used.
    - Do not store food, drinks, or personal belongings in areas where radioactive material is stored or used.
    - Never pipette anything by mouth
    - Monitor hands, feet, and clothing for radioactive contamination after each procedure using radioactive materials, before leaving the area.
    - Dispose of radioactive waste only in EHS-approved, labeled, and properly shielded receptacles. Never dispose of radioactive materials in regular trash or down the drain.

C. Additional Safety Requirements

In laboratory areas that are shared by multiple users where not all personnel have been trained to work with radioactive materials, additional precautions need to be taken to address exposure and to minimize the potential spread of contamination. The recommended additional precautions include, but are not limited to, the following:

- Limiting quantities of radioactive materials to be used in open shared lab areas. These limits can be evaluated by the RSO on a case-by-case basis.
- Adequately shielding radioactive materials on all sides to ensure exposures are maintained under 2 mrem/hr at one foot from the source.
- Keeping laboratory doors closed or working inside a chemical fume hood with the following uses/applications:
    - Working with amounts of stable, non-volatile radioactive materials in excess of the recommended possession limits for shared laboratories
    - Procedures that may produce small amounts of radioactive aerosols such as using a microcentrifuge or speed-vac.
    - The use of unstable or volatile radioactive materials
- All areas where radioactive materials are used, including but not limited to the following, must be labeled with the universal radiation symbol:
    - Laboratory work benches
    - Chemical fume hoods
    - Sinks where radiation may be introduced through disposal or cleaning of contaminated lab materials.
    - Laboratory equipment such as refrigerators, centrifuges, incubators, etc.

12. Laboratory and Facility Requirements

KSU laboratories are designed in accordance with the University System of Georgia's Design Criteria for Laboratories, and as designed, are suitable for working with low levels of stable, non-volatile radioactive materials.

A. Laboratory Features

The following design features are required for laboratory use of radioactive materials:

- Smooth, non-absorbent floors (e.g., no carpet, rugs, etc.)
- Smooth, non-porous countertops that will not absorb radioactive materials.
- Non-porous furniture that will not absorb radioactive materials.
- Hand washing sinks with non-permeable surfaces designed to allow complete draining.
- HVAC system with negative directional airflow and one-pass ventilation

B. Additional Features

An increase in the possession limit, volume of radioactive materials used, and/or a change in the level of stability of the materials may require the lab to incorporate additional features to ensure that exposure is maintained ALARA. These features include, but are not limited to chemical fume hoods, various shielding designs, and or designated enclosed spaces.

C. Equipment/supplies

The following equipment will be needed when working with radioactive materials, dependent upon the radioisotopes used:

- Detection equipment such as Geiger-Muller survey meters (not needed for H-3) for contamination surveys.
- Filter paper or cotton swabs, glass scintillation vials, and liquid scintillation fluid for wipe testing
- A liquid scintillation counter and/or gamma counter for processing wipe tests
- Shielding materials such as Plexiglas or lead, depending upon the radioisotopes used

13. Security and Storage of Radioactive Materials

The following measures must be implemented for the secure use and storage of radioactive materials:

- All users of radioactive materials must be authorized and trained in general radiation safety and must be proficient in the specific protocols that apply to radioactive materials prior to using the materials.
- All authorized users and radiation workers must be familiar with the properties of the radioactive materials they are using, including RAM type, energy, half-life, and chemical form.
- The protocol for each project/experiment using radioactive materials must be well documented and approved by the RSC.
- Doors of laboratories where radioactive materials are used must be secured by key card or hard key.

- Doors must be closed and locked when the lab is not occupied.
- Radiation permit holders must choose a method of securing the radioactive materials they possess (in addition to key-card or locked doors) using the following options:
    - A locked freezer or refrigerator.
    - A locked compartment or cabinet within the lab.
    - A locked storage box kept inside a freezer or refrigerator.
    - A locked interior room inside the lab.
    - In a laboratory where storage space such as freezers and refrigerators are shared between different researchers, a locked box inside the freezer, refrigerator, or cabinet is required. The locked box must also be secured to prevent easy removal.
- Experiments using radioactive materials must never be left unattended when not in use in order to prevent unauthorized use or transfer.
- Radioactive waste must be stored in a facility that is secure at all times.
- Radioactive materials must be used only in the areas authorized by the RSC.
- Access to radiation permitted areas must only be given to individuals who are trained and under the permitholder's authorization or otherwise authorized under the RSC or EHS.

14. Signs and Postings

The following is a list of signage that must be posted for radioactive materials use:

- A "Caution, Radioactive Material" sign must be posted on the door of any area where radioactive material is used or stored.
- A "Notice to Employees" sign from the Georgia Department of Natural Resources must be posted in areas to permit employees working in or frequenting any portion of a controlled area to observe a copy on the way to or from the place of employment.
- A "Caution: Radiation Area" sign must be posted at any area where a person may receive 5 mrem in an hour.
- Other signage such as "High Radiation Area" may be required in areas with higher radiation exposure rates or airborne radioactivity. Consult the RSO for guidance if these circumstances may exist.

A. Posting Exceptions

The following areas are exempt from posting requirements:

- Areas where radioactive material is only present for less than 8 hours, and where someone is monitoring the dose rate to ensure that exposures do not exceed regulatory limits.
- Areas where only sealed sources are stored, and the dose rate of any sealed source is less than 5 mrem/hr. at 30 cm from the surface.

B. Labeling Requirements

- Stock containers of Radioactive Material must be labeled displaying the universal radiation symbol and the words, "Caution, Radioactive Material", the radionuclide, quantity of radioactivity and date of assay.

- Designated areas where radioactive materials are used must be labeled with the universal radiation symbol and the words "Caution, Radiation Area."
- Labeling of instruments, secondary containers, racks of samples, or trays is also recommended.
- Radioactive waste must be labeled with the universal radiation symbol, the words, "Caution, Radioactive Materials," the radioisotope, the estimated activity, and the date when the container was closed, or became full.

15. Procurement of Radioactive Materials

Radioactive materials must be procured with prior authorization from EHS, and only from vendors who have a radioactive materials license through the NRC and/or an Agreement State. Each vendor that sells radioactive materials is required by state and federal regulations to possess a valid license to package, sell, and ship these materials. Prior to ordering radioisotopes, a copy of the KSU broad scope license will be provided to the vendor. Other information may need to be provided as well, such the location to deliver the material and payment information.

A. Ordering Radioactive Materials for Research Laboratories

- All requisitions for radioactive materials must receive prior approval through EHS.
- A permit holder/authorized user cannot order radioactive materials directly from the vendor.
- Prior to submitting an order, EHS must verify that the permit holder has a currently active permit to use the requested isotopes, and that the activity requested is within their approved permit limits.

Permit limits must not exceed the total of radioisotope + radioactive waste materials the permit holder has on hand at any given time.

- Replacements for incorrect orders or damaged shipments must be negotiated through EHS.
- The requisition must contain the following information:
    - Name of the radiation permit holder
    - Authorization number
    - Vendor/supplier
    - Vendor/supplier catalogue number
    - Radioisotope
    - Chemical compound/form
    - Activity in µCi or mCi
    - Quantity (number of units)
- After verification by EHS that the permit holder has an active permit to possess the material, and that the order will not exceed the possession limit, the order will be processed and finalized.

- EHS will communicate with the vendor and confirm the delivery date and time (if available) that the radioisotope(s) will be delivered to the appropriate designated/restricted area at KSU.

B. Transferring Radioactive Materials

There may be circumstances that require a permit holder to request the transfer of radioactive materials at no cost, such as transfer from another institution, or to ask for a replacement product from a vendor/supplier. If possible, a requisition with zero cost entered should be entered and submitted. The same procedure for ordering radioactive materials applies.

C. Transferring Radioactive Materials within KSU

When transferring radioactive materials between permit holders within KSU, the following steps must be followed:

- EHS must verify that the recipient has an active permit to possess the material, and that the transfer of the radioactive materials will not exceed the possession limit.
- Once this is verified, a **Transfer Agreement** must be completed and signed by both parties involved in the transfer.
- The Transfer Agreement must be submitted to the RSO for approval before the material is transferred.
- The Transfer Agreement must be approved and signed by the RSO prior to the transfer of the material.
- The material must not be released to the recipient until the transferor receives the Transfer Agreement signed by the RSO.

Any transport of radioactive material across public roads must be done in compliance with all DOT/IATA regulations. Contact EHS for information for assistance with hazardous materials transportation.

16. Receiving Packages of Radioactive Materials

Packages of radioactive materials cannot be delivered directly to laboratories from the courier. EHS will receive the package(s) and will open and check the package for accuracy of contents and any possible leakage/contamination. Once the package(s) has been checked-in, EHS will deliver them to the requestor and obtain a signature of receipt.

A. Procedure for Receiving Packages

The receipt of packages/shipments of radioactive materials must follow specific steps to ensure that all the appropriate information is accounted for, and that the end user receives a package that is free of contamination. Any EHS staff member who will be responsible for the initial receipt of packages from the courier must be trained in the procedure and the proper precautions to be taken. For more information, access the **Procedure for Radioactive Package Receipt**.

- Once received, the appropriate information from the packing slip and/or other documentation must be entered into the RadioLogistix database.
- The package must be delivered to the end user by an EHS staff member.
- Upon delivery, the PI or lab employee must sign for receipt of the package.
- If there is no one present to sign for the package upon delivery, it will be returned to the EHS delivery location.
- After a failed delivery, an EHS staff member will attempt to contact a lab employee to schedule a time for delivery.
- Once the package has been delivered to the lab, the labels (e.g., white I, yellow II) on shipping boxes must be defaced.
- If the shipping box is discarded, it must first be defaced, wipe tested and have no removable contamination. If removable contamination is found, the container should be disposed of as radioactive waste.

17. Transport of Radioactive Materials

A. Regulatory Requirements

- Radioactive materials to be shipped must be packaged and transported in accordance with state and federal regulations.
- Radioactive materials can only be packaged and shipped by individuals who have been trained and are currently in the Department of Transportation (DOT) and International Air Transport Association (IATA) training per regulations.
- DOT regulates the shipping of hazardous materials by road, rail, or water, and training on their regulations must be completed every 3 years.
- IATA regulates the shipping of hazardous materials by air, and training on their regulations must be completed every 2 years.

B. Transporting Radioactive Materials at KSU

- Contact EHS for assistance with transporting/shipping of radioactive materials.
- Radioactive materials must not be transported in personal vehicles, on public transportation, on the Big Owl Bus (BOB), or any other means of transportation on or around campus.
- Prior to transporting radioactive materials offsite, the following conditions must be met:
    - The recipient must have a current license with the NRC or Agreement State
    - EHS must have a copy of this information to ensure that the recipient is legally authorized to receive the material and the quantity being sent.
    - The appropriate **Transfer Form** must be completed and signed by the RSO.
    - EHS must properly prepare and package the material for shipping.

18. Maintenance of the Radioactive Materials Inventory

Upon the receipt of radioactive materials, the permit holder/authorized user is required to accurately manage the radioactive materials inventory for all radioisotopes received and in his/her possession. All radioactivity amounts received must be recorded in the RadioLogistix online database. For assistance on how to use RadioLogistix, contact the RSO to schedule training.

A. Entering Shipment Information into RadioLogistix (EHS)

When a shipment of radioactive materials is received by EHS, information from the packing slip, stock vial, and other information is entered into the RadioLogistix database. This information includes but is not limited to radioisotopes, radioactivity, chemical medium, and volume. Once the information has been entered, the RadioLogistix database accounts for radioactive decay over time, which negates the need to manually calculate current activity.

B. Tracking Radioactive Materials Use (End-User)

The permit holder/authorized user must also maintain an accurate account of the use of radiation in their lab.

- Permit holders/authorized users must keep track of the use of all radioactive materials in his/her possession.
- This use will be tracked in the RadioLogistix online database, which can be accessed by using your KSU login credentials.
- The following information must be entered into RadioLogistix to track radioactive materials use:
    - Stock vial that radioactivity is removed from.
    - Date that radioactivity is removed from the stock vial.
    - Amount of material extracted from the stock vial (in milliliters), and
    - Anticipated waste stream (dry, liquid, or mixed with liquid scintillation fluid) that it is destined for, are the items to be recorded.

19. Radioactive Waste Management

All waste materials used in experiments with radioisotopes, including but not limited to paper towels, pipette tips, benchtop paper, disposable gloves, aqueous and chemical mixtures, must be disposed of as radioactive waste. Generally, there are three separate waste streams for radioactive waste: dry waste, liquid scintillation vial waste, and liquid waste. These materials are regulated under OCGA 391-3-17 and must not be disposed of via regular waste stream. All radioactive waste must be collected in EHS approved containers, separated by radioisotope, and by waste type.

A. General Rules for Radioactive Waste Management

The following general rules apply in the management of waste materials associated with the use of radioactive materials:

- Radioactive waste must never be disposed of as regular waste, but via the appropriate radioactive waste stream.
- Mixing of radioactive waste streams is prohibited (e.g., liquid scintillation vials cannot be mixed with dry waste).
- All radioactive waste materials must be disposed of through EHS.
- Label all radioactive waste with all required information:
    - Universal radiation symbol
    - The words, “Caution, Radioactive Materials”
    - Radioisotope
    - Activity

    - Date when the container was closed or became full.
- Waste containers should not be overfilled.
- All waste containers should remain closed unless adding waste to prevent spills and the potential spread of contamination.
- Radioactive waste must be shielded to minimize exposure to lab personnel.
- Prior to disposal, all short-lived radioactive waste must be stored for ten half-lives, or until the radiation level reaches background. This will be done after EHS has picked up the radioactive waste.
- Deface all primary containers/vials before disposing of radioactive waste (i.e., mark through all radiation symbols and precautionary statements).

B. Collection of Radioactive Waste

Radioactive waste must be collected in containers provided by the EHS and are as follows:

- Dry waste is collected in 5-gallon sealable buckets or 20-gallon drums
- Liquid scintillation vial waste is collected in 5-gallon sealable buckets
- Liquid waste is collected in plastic 1-gallon containers
- Any alternative containers used to collect radioactive waste must be first approved by EHS.

C. Separation of Radioactive Waste Types

1. Laboratory Waste Materials

- Short-Lived Dry Waste (half-life < 120 days) must be collected in separate containers (5-gallon or 20-gallon). Examples of short-lived isotopes are P-32, S-35 and I-125.
- Short-Lived Aqueous Waste (half-life <120 days) must be collected in plastic, one-gallon containers.
- Long-Lived Dry Waste (half-life >120 days) must be collected in separate containers (5-gallon or 20-gallon). Examples of long-lived isotopes are H-3 and C-14.
- Long-Lived Aqueous Waste (half-life > 120 days) must be collected in plastic, one-gallon containers.
- Liquid scintillation vial waste (i.e., glass vials that contain filter paper and liquid scintillation fluid) is only collected in five-gallon containers to minimize weight.
- All radioactive waste must be separated according to radioisotope.

Aqueous waste that contains radioactive material, potentially biohazardous materials, and/or materials capable of supporting bacterial growth, must be disinfected by the lab prior to disposal. Mixing chemical and radioactive waste is generally prohibited but can be evaluated by EHS on a case-by-case basis prior to beginning the experiment.

2. Radioactive/Biohazard Waste Materials

- Contaminated sharps must be stored in sharps containers labeled with both the universal biohazard symbol and the universal radiation symbol. If they are

contaminated with short-lived radioisotopes, they must be stored for 10 half-lives before being disposed of as biohazard waste.

- Filled sharps containers that are ready for disposal must be collected in appropriate biohazard bags.
- Bags must be knotted according to the waste disposal protocol, sealed in a cardboard box displaying the universal biohazard symbol as well as the universal radiation symbol.
- The box must be stored in the designated storage area.
- A label with the following radiation information must be placed on the outside of the box:
    - Contents of the container
    - Permit holder's name
    - Radioisotope
    - Total activity
    - Date of collection

D. Container Labeling

Radioactive waste containers must be labelled with the following information prior to discarding waste:

- Radioisotope used with the waste materials.
- Permit holder/authorized user's name.
- Unique container number provided by the RadioLogistix database.

When containers are being prepared for disposal through EHS, survey the container and add the following information:

- Amount of radioactivity in the container, as calculated in RadioLogistix
- Radiation exposure measurements at the surface of the container and at one meter from the container (mrem/hr.)
- Date of the survey
- Name/initials of the surveyor

Any lead shielding must be disposed of separately from all other waste materials through EHS.

20. Radiation Detection Instruments

A. Required Instrumentation for Working with Radiation

- When working with radioactive materials, a permit holder/authorized user must have radiation detection and/or counting/measuring instruments available for use. Examples of these instruments include Geiger Muller (GM) survey meters, liquid scintillation counters, and gamma counters.
- When applying for a radiation use permit, this is one of the conditions for approval.
- The instrumentation needed is dependent upon the radioisotopes that will be used in the lab.

- Prior to approving applications for the use of radioactive materials, the RSO and the RSC will review the application to ensure that the appropriate instrumentation is available to detect the radioisotopes that are in the application.
- If the applicant does not have the appropriate instrumentation for radiation detection and/or counting, the proper instrumentation must be purchased for use in the lab, or borrowed from another permit holder. While borrowing is an option, it is not meant to be a long-term solution, as each permit holder needs his/her own instrumentation.
- Permit holders who need GM survey meters to detect radiation should plan on purchasing their own instrument. However, more expensive equipment such as liquid scintillation counters and gamma counters may be shared by permit holders within a department.

B. Geiger Muller Survey Instruments

Geiger Muller (GM) survey meters are used to detect surface contamination during/after use of higher energy radioisotopes that can be detected using them.

GM Survey meters can be purchased from several manufacturers/suppliers, including Ludlum Measurements, Spectrum Technologies, Eberline Industries, ThermoFisher Scientific, etc.

One of the most common, and highly recommended survey meters is a Ludlum Model 3 GM survey meter with a Model 44-9 "pancake" probe. The survey meter must meet two requirements:

1. It must have an external detector for surveying surfaces for contamination
2. It must be able to read in either millirem per hour (mrem/hr.), counts per minute (CPM), counts per second (CPS), or a combination.

Survey meters must be calibrated every 12 months from the date last calibrated while radioactive materials are being actively used in the lab. They should be returned to the manufacturer for calibration or shipped/transported to a qualified vendor that provides calibration services.

Calibration must be accompanied by the following:

- A calibration certificate.
- A calibration label to be affixed to the instrument indicating the following:
    - The next date recalibration is due (12 months from the date calibrated)
    - Model number or the meter and the attached detector
    - Serial Number of the meter and attached detector
    - Scales calibrated and the % error range
    - The signature or initials of the calibrator

While a permit holder's survey meter is being calibrated, he/she must still have access to a survey meter. The RSO will work with permit holders to borrow a survey meter until theirs is calibrated and returned.

The cost of the calibration and any repairs needed on the meter is the responsibility of the permit holder.

21. Working With Radiation-Producing Machines

"Radiation-producing machines" include x-ray machines, DEXA bone scanners, electron microscopes, and any other machines that produce ionizing radiation under normal operation. All uses of machine- generated radiation must be in accordance with the State of Georgia Rules and Regulations for X- Ray, OCGA 111-8-90.

All researchers and students who would like to use radiation-producing machines in academics or as part of their research must be approved by the RSC as authorized users and/or radiation workers.

A. General Requirements

The following general considerations must be made when working with radiation producing machines/equipment:

- Radiation producing machines must be approved by EHS prior to acquisition through purchasing.
- EHS must be made aware of the make, model, serial number, and proposed location for the device.
- Radiation producing equipment must be registered with the State of Georgia Department of Community Health.
- Only individuals who are approved as either authorized users or radiation workers may operate radiation-producing machines.
- Only individuals who have completed radiation safety training and have been trained in the specific operation of the unit(s) may operate radiation-producing machines.
- Operators who are likely to receive 10% of the annual occupational dose limits (see Table 1) must be assigned and wear radiation monitoring devices (i.e., badges).
- Operators who are assigned two badges must wear a badge on the torso under a lead apron and a badge in the collar area outside the lead apron.
- Operators who are assigned only one badge must wear the badge in the collar area outside of a lead apron.
- Operators must make every effort to keep radiation exposure ALARA by limiting the operation of radiation-producing equipment to the minimum possible time and lowest dose rate possible.
- Operators must never directly expose any part of themselves directly to radiation unless properly shielded.
- Non-essential personnel must be required to leave the work area when radiation-producing machines are in operation.
- A hazard assessment must be conducted by EHS on both the work area and the unit prior to initial operation to determine if modifications to the work area need to be made (e.g., lead shielding).
- Any unsafe conditions or perceived instances of overexposure should be reported to the RSO immediately.

B. Posting/Signage

Areas where radiation-producing equipment will be used must be posted (i.e., at area entrances) with a sign that reads "Caution Radiation" and is marked with the characteristic radiation "trefoil" symbol.

In addition to this standard posting, controls for radiation producing equipment must have a posting that reads as follows: "Warning: This x-ray unit may be dangerous to patient and operator unless safe exposure factors and operating instructions are observed."

C. Equipment Surveys

All radiation-producing equipment must be inspected/surveyed initially and annually thereafter by EHS or a qualified expert to ensure they are working properly, and radiation emissions are maintained at safe levels.

The equipment must be inspected after any changes are made that may affect the radiation output (e.g., replacement of parts, altering the beam attenuation, etc.)

Any protective devices used (e.g., lead aprons, skirts, vests, collars, etc.) should be inspected at least annually for leakage.

22. Radiation Inspections and Surveys

The RSO will conduct periodic radiation audits/inspections in order to certify that radioactive materials are being used in a safe manner, in accordance with the conditions of the RAM license, and in compliance with all state and federal regulations. Frequency of inspections are usually quarterly, but may be more frequent depending upon the quantity and type of RAM used, previous inspection results, and the level of compliance with policies and regulations.

A. Laboratory Audits/Inspections

Prior to conducting a quarterly laboratory audit, the RSO or designee will review all radiation documentation associated with radiation use in the lab, including but not limited to the radiation permit/authorization, lab location, training history of radiation workers, previous inspection results, radiation usage, and radiation detection device records. After reviewing this information, the RSO will conduct a scheduled or unscheduled audit of the radiation work area of the permit holder. During the audit, the RSO will audit/inspect the following items including but not limited to:

- Training records
- RAM authorization records
- RAM inventory and radiation usage logs
- Wipe test frequency and results
- Presence and current calibration of detection devices
- The RAM work area(s),
- RAM storage area(s),
- Radioactive waste collection area(s), where appropriate
- Correct wearing and/or storage of dosimetry
- Appropriate attire and PPE for radiation usage

- Storage methods to secure radioactivity
- Postings

The following radiation surveys will also be conducted as appropriate:

- GM meter surveys
- Area wipe tests
- Leak testing for sealed sources
- Survey testing for radiation producing machines
- Dose exposure rate in work areas

B. Audit/Inspection Reports

The RSO will generate inspection reports based on the findings of the inspections/surveys. The reports will prescribe corrective actions and will be distributed to the appropriate authorized user(s)/permit holder(s). The authorized user must respond to the RSO within 5 business days describing how any item(s) of non-compliance will be corrected. Items of non-compliance must be addressed within the allotted timeframe.

C. Failure to Address Corrective Actions/Repeat Violations

Items of non-compliance documented during lab audits/inspections must be addressed in the timeframe allotted by the RSO. Failure to complete the corrective actions will be reported to the RSC and may result in temporary suspension of the permit until the items have been addressed. Repeating violations and/or violations that have the potential to result in excessive exposure or injury will also be reported to the RSC and may result in indefinite suspension of the permit, where the permit holder will be required to be retrained and reapply for a permit.

23. Protocol for Radiation Incidents/Emergencies

All incidents/emergencies involving the use of radioactive materials require immediate action in order to minimize exposure. These events can include (not limited to) spills of radioactive materials, breakage or damage to sealed sources, and contamination to work surfaces or personnel. If a radiation incident/emergency occurs, it must be reported to the permit holder/immediate supervisor and the RSO immediately.

A. Minor Radiation Spills

If a radioactive spill occurs, follow these steps:

- Lab personnel in the immediate vicinity of the spill must stop working immediately.
- All nearby personnel must be informed of the event, and everyone not in the immediate area must be instructed to stay away.
- Individuals who are in the immediate vicinity must remain to have their shoes and clothing surveyed and/or wipe tested for contamination.
- Isolate the contaminated area, but do not leave the area.
- If not already wearing the appropriate PPE, don the appropriate PPE for working with radioactive materials (i.e., lab coat, nitrile gloves, and safety goggles).
- Layer the spilled material with absorbent materials.

- Clean-up all visible contamination using an outside to inward method to prevent further spreading the contamination.
- Use the GM survey meter and/or wipe tests to check for removable contamination.
- If contamination is detected on the surface, decontaminate the contaminated surfaces using appropriate cleaning solution(s) and absorbent materials, taking caution to prevent further spreading the contamination.
- Re-survey the contaminated area using the GM survey meter and/or wipe tests.
- Repeat decontamination steps as necessary until all removable surface contamination has been removed.

If no more surface contamination can be removed, but contamination can still be detected via GM survey, it may be necessary to remove the contaminated portion of the surface.

- Discard all gloves, absorbent materials, and other materials used to decontaminate the spill into the appropriate radioactive waste stream.
- Complete an Incident Investigation Report in Reliance.

B. Major Radiation Spills

In the event of a major spill that cannot be addressed by lab personnel, follow these steps:

- Notify all lab personnel of the incident. Instruct everyone to leave the room but remain in the area so they can be surveyed for contamination (i.e., hands, shoes, and clothing).
- Cover/contain the spill as much as possible with absorbent materials.
- Leave the room. Do not attempt to clean/decontaminate the spill.
- Contact the RSO immediately.
- All personnel, including the surveyor, must be surveyed and/or wipe tested for contamination in an area away from the spill.
- If personnel are found to be contaminated, start the decontamination process as follows:
    - Have them remove contaminated clothing items/shoes
    - Survey skin for contamination
    - If skin is contaminated, rinse the contaminated area(s) with water, and then wash with soap and water. The RSO will need to know where this was done, as the sink/shower will need to be temporarily placed out of service.
- Personnel should not re-enter the work area until EHS until EHS has completed mitigation measures and has given approval for re-entry.
- Complete an Incident Investigation Report in Reliance. EHS will follow up with an investigation to determine the root cause(s) of the spill and to advise on future prevention measures.

C. Personnel Contamination

- Personnel contamination must be reported to the RSO immediately.

- Contaminated clothing must be removed and either discarded as radioactive waste (if contaminated with long-lived isotopes) or stored for 10 half-lives prior to returning to the owner (if contaminated with short-lived isotopes).
- Contaminated skin must be washed with soap and water until contamination can no longer be detected.
- Complete an Incident Investigation Report in Reliance.
- A contamination survey will also need to be recorded indicating the radioisotope(s) the individual was exposed to, the length of exposure, calculated dose, the date/time the survey was recorded, and the person who conducted the survey.

D. Accidents and Injuries Involving Radiation

When a radiation injury/emergency occurs, **seek medical attention immediately.** Contact KSU Police at **470-578-6666**, who will arrange transportation to a medical facility.

- Be sure to inform the first responders and medical professionals of any radiation contamination.
- Be prepared to inform the attending physician of the source of the injury.
- Inform the permit holder/authorized user and the Radiation Safety Officer (470-578-3321) as soon as possible. If the incident occurs after hours, contact KSU Police, who will contact the RSO.
- When possible, complete an Incident Investigation Report in Reliance.

E. Fire

Lab personnel may extinguish small fires by using a fire extinguisher, but only if trained in the use of fire extinguishers and are comfortable doing so. For large fires and/or explosions:

- Leave the work area immediately.
- Instruct all personnel to clear the area but remain in the immediate vicinity for surveying.
- Call KSU Police at **(470) 578-6666** and EHS at **(470) 578-3321**.

If the fire department has been dispatched, inform them where radioactive materials and/or radioactive waste materials are stored inside the lab to prevent their exposure or the spread of possible contamination.

- Isolate the area to prevent the spread of possible contamination.
- Survey all people who may have been contaminated during the process.
- Decontaminate personnel by removing contaminated clothing and washing contaminated skin soap and water.

Once it has been determined that the fire hazard has been mitigated, decontaminate the affected areas per protocol. Do not allow anyone to re-enter the area until EHS has given approval to do so.

F. Environmental Release

If radioactive materials are accidentally released into the environment (e.g., via drain, chemical fume hood, etc.), inform the RSO immediately. The determination will need to be made whether the event needs to be reported to Georgia Department of Natural Resources.

G. Lost or Missing Radioisotopes

If any quantity of radioactive material is believed to be lost or stolen, the incident must be reported to the RSO immediately. The RSO will initiate the following steps:

- Investigate the incident by interviewing the permit holder and/or radiation workers.
- Work with the permit holder/radiation workers to locate and recover the lost material
- Make the determination whether the loss must be reported to Georgia Department of Natural Resources, and report as necessary in accordance with the regulations

24. Program Evaluation

The RSO, in conjunction with the Radiation Safety Committee, will evaluate the Radiation Safety Program to ensure that all its components work effectively. The Radiation Safety Program elements will be reviewed periodically, and changes will be made as necessary to ensure that all work with radioactive materials is conducted in a safe manner, and in accordance with the KSU RAM license, and all federal and state regulations.

25. Record Keeping

All documentation associated with the use of radioactive materials must be retained in accordance with the KSU RAM license and applicable regulations. Records must be kept as follows:

A. Responsibility of Authorized User(s)

- Current User Permit under the KSU license
- Current RAM Inventory
- Current RAM usage logs
- Instrument calibration records
- Standard operating procedures and protocols involving the use of radioactive materials
- Copies of training records of authorized users and radiation workers
- Contamination survey reports

B. Responsibility of EHS/RSO

- Current KSU RAM license
- Copies of standard operating procedures and protocols involving the use of radioactive materials
- Current radioactive materials Inventory
- Training records of authorized users and radiation workers
- Radiation audits/inspections, contamination surveys, and leak tests
- Instrument calibration reports

- All personnel dosimetry/monitoring reports (length of employment plus 30 years)

26. References

- U.S. Nuclear Regulatory Commission – Title 10, Code of Federal Regulations
- State of Georgia OCGA 391-3-17
- State of Georgia OCGA 111-8-90