

JANUARY 1, 2023



RADIATION SAFETY HANDBOOK

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I. Purpose

The University of North Carolina at Charlotte is licensed by the North Carolina Radiation Protection Section (NC RPS) (<http://www.ncradiation.net>) to possess and use certain radioactive materials and is registered to use ionizing radiation producing machines. The specific regulatory requirements are outlined in Title 10A of the North Carolina Administrative Code (NCAC) Chapter 15 (titled Radiation Protection).

II. Scope

This Handbook has been prepared by the UNC Charlotte Environmental Health and Safety Office (EHS) as a guide for persons using radioactive materials and/or ionizing radiation producing machines in an effort to meet the conditions of the UNC Charlotte licenses and registrations. In no case should any statement in this Handbook be construed to be a variance from any federal or state regulation.

It should be noted that there are specific ionizing radiation producing machines located at UNC Charlotte that require device specific safety guidelines that fall outside of the scope of this document. This currently includes the following devices:

- DEL MEDICAL Model: CM 200 50 KW
- GE MEDICAL SYSTEMS Model: PRODIGY
- Adelphi Model: DD-108 Neutron Generator

Persons using any of those devices should follow the instructions in the appropriate device specific Radiation Safety Manual prepared for those facilities.

It is the responsibility of every authorized user of radioactive materials and/or ionizing radiation producing machines to be familiar with and adhere to the requirements set forth in this Handbook and the North Carolina Regulations for Protection against Radiation. These documents are available in the EHS Office.

III. Definitions

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

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

"ALARA" (acronym for "as low as is reasonably achievable") means making every reasonable effort to maintain exposures to radiation as far below the dose limits in the rules of this Chapter 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

the public health and safety, and other societal and socioeconomic considerations, and in relation to utilization of sources of radiation in the public interest.

"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. ALI is the smaller value of intake of a given radionuclide in an effective dose equivalent of five rems (0.05 Sv) or a committed dose equivalent of 50 rems (0.5 Sv) to any individual organ or tissue. The ALI values for intake by ingestion and by inhalation of selected radionuclides are given in Table 1, Columns 1 and 2, of Appendix B of 10 CFR 20.1001 - 20.2401.

"Authorized user" means an individual who is authorized by license or registration condition to use a source of radiation.

"Background radiation" means radiation from cosmic sources; naturally occurring radioactive materials, 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 are not under the control of the licensee or registrant. "Background radiation" does not include sources of radiation regulated by the agency.

"Becquerel" is the SI unit of radioactivity. One becquerel is equal to one disintegration per second (s⁻¹).

"Bioassay" or "radiobioassay" means the determination of kinds, quantities or concentrations, and, in some cases, the locations of radioactive material in the human body, whether by direct measurement (in vivo counting) or by analysis and evaluation of materials excreted or removed from the human body.

"Curie" is the special unit of radioactivity. One curie is equal to 3.7×10^{10} disintegrations per second = 3.7×10^{10} becquerels = 2.22×10^{12} disintegrations per minute.

"Declared pregnant woman" means a woman who has voluntarily informed the licensee or registrant, in writing, of her pregnancy and the estimated date of conception. The declaration remains in effect until the declared pregnant woman withdraws the declaration in writing or is no longer pregnant.

"Decommission" means to remove (as a facility) safely from service and reduce residual radioactivity to a level that permits release of the property for either unrestricted use and termination of the license or for restricted use and termination of the license.

"Dose" or "radiation dose" is a generic term that means absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, or total effective dose equivalent, as defined in other Items of this Rule.

"Exposure" means being exposed to ionizing radiation or to radioactive material.

"Exposure rate" means the exposure per unit of time, such as R/min and mR/h.

"External dose" means that portion of the dose equivalent received from radiation sources outside the body.

"Extremity" means hand, elbow, arm below the elbow, foot, knee, or leg below the knee.

"Eye dose equivalent" (See "Lens dose equivalent" as defined in this Rule).

"Medical use" means the intentional internal or external administration of radioactive material or the radiation therefrom to patients or human research subjects under the supervision of an authorized user.

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

"Monitoring," "radiation monitoring" or "radiation protection monitoring" means the measurement of radiation levels, concentrations, surface area concentrations or quantities of radioactive material and the use of the results of these measurements to evaluate potential exposures and doses.

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

"Sealed source" means radioactive material that is encased in a capsule designed to prevent leakage or escape of the radioactive material.

"Source of radiation" means any radioactive material, or any device or equipment emitting or capable of producing radiation.

IV. Program Responsibilities

A. Radiation Protection Program

Procedures and engineering controls shall be used to achieve occupational doses and doses to members of the public and releases of radioactive materials that are As Low As Reasonably Achievable (ALARA).

At least annually, the UNC Charlotte Radiation Safety Program shall be reviewed for program content and proper implementation of procedures in accordance with the *North Carolina Regulations for Protection Against Radiation*.

B. Radiation Safety Committee

The Radiation Safety Committee (RSC) includes individuals experienced in the use and/or application of radioactive materials and/or ionizing radiation producing devices. The purpose of the RSC shall be to act in an advisory capacity to assist with the implementation of the radiation safety program to ensure that the radiation usage at UNC Charlotte is conducted in accordance with ALARA and at the lowest risk possible to the University community.

Radiation Safety Committee (RSC) will convene a meeting to review radiation safety program information per regulatory requirements and/or special investigation.

C. Radiation Safety Officer

The (RSO) shall be appointed by the University and acceptable to the North Carolina Radiation Protection Section (NC RPS) as qualified to advise University members on safety matters pertaining to ionizing radiation and implementing all aspects of the University radiation safety program. The RSO position is housed within the Environmental Health and Safety (EHS) Office.

Responsibilities of the RSO are:

1. Establish and oversee operating, safety, emergency, and ALARA procedures to ensure that the procedures are current and conform with 10A NCAC 15 rules;
2. Oversee and approve all phases of the training program for operations and/or personnel so that appropriate and effective radiation protection practices are taught;
3. Ensure that required radiation surveys and leak tests are performed and documented in accordance with license conditions and regulations, including corrective measures when levels of radiation exceed established limits;
4. Ensure that personnel monitoring is used properly by occupationally exposed personnel, that records are kept of the monitoring results, and that timely notifications are made as required by N.C. regulation;
5. Investigate and submit appropriate documentation to NC RPS for each known or suspected dose limit violation and each theft or loss of source(s) of radiation, to determine the cause(s), and to take steps to minimize a recurrence.
6. Investigate and submit a report to the N.C. RPS for each known or suspected case of release of radioactive material(s) to the environment in excess of limits established by N.C. regulations;
7. Have knowledge of management policies and administrative procedures established in the license;
8. Review and provide provisional approval, as needed of Principal Investigator applications, amendments, protocols and possession limits;
9. Assume control and have the authority to institute corrective actions, including shutdown of operations when necessary in emergencies or unsafe conditions;
10. Ensure that records are maintained as required by 10A NCAC 15 regulations;
11. Ensure the proper storing, labeling, transport, and use of sources of radiation;
12. Ensure that radioactive material inventories are tracked enabling the establishment of compliance with license activity limits;
13. Ensure that personnel are complying with these rules, the conditions of the license, and the operating, safety and emergency procedures of the license related to proper disposal of radioactive materials.

D. Authorized User

Authorized Users (AU) are faculty or staff members who have been approved to use radioactive materials or radiation producing machines. The AU will normally be the Principal Investigator (PI) of a research project involving radiation or the faculty member responsible for a course with laboratory or field exercise in which radiation is used. Although faculty members may use radiation under another faculty member's authorization each faculty member is encouraged to obtain their own authorization.

Each Authorized User shall:

1. Establish and maintain a culture for radiation safety awareness in the workplace. This shall include control of radiation exposure consistent with the ALARA philosophy of radiation protection;
2. Ensure the following laboratory safety services are provided:

- a. Appropriate personnel dosimetry ([RAS Form 2](#));
 - b. Bioassay services if warranted;
 - c. Personal protective equipment, as appropriate;
 - d. Availability of appropriate and calibrated survey instrumentation;
 - e. Facility maintenance.
3. Follow procedures for procurement of radioactive materials and radiation producing devices;
 4. Provide correct and current posting of laboratory areas, radioactive material containers and radiation- producing machine;
 5. Ensure maintenance of accurate and current inventory records for all radioactive materials under his or her responsibility ([RAS Form 6](#));
 6. Follow established procedures for packaging, inventory listing, disposal and notification of the EHS Office for collection of radioactive wastes ([RAS Form 7](#));
 7. Immediately report any potentially hazardous spills, suspected radiation overexposures, loss or theft of radioactive materials, or other incidents having possible radiation safety implications to the EHS Office;
 8. Perform radiation and contamination monitoring as required by applicable regulations, procedures in this manual, and license commitments. Maintain accurate records of such monitoring results ([RAS Form 4](#));
 9. Ensure that all radiation workers are properly trained on specific radioactive materials (RAM)/radiation producing machine usage protocols, nuclide safety data sheets, emergency procedures and security requirements within their area of accountability and provide refresher awareness training to radiation workers and laboratory workers;
 10. Notify the EHS Office of any need for changes in the authorized use of licensed materials or registered equipment, including changes in use as well as a possession limit increase.
 11. Obtain written approval for procurement of radioactive materials from the EHS Office ([RAS Form 3](#));
 12. Follow established procedures for transfer of licensed radioactive materials to other UNC Charlotte authorized users ([RAS Form 8](#));
 13. Notify the EHS Office in the event of anticipated extended absence from UNC Charlotte. An Authorized user may declare their laboratory “inactive” using [RAS Form 12](#) when they anticipate extended periods with no use of radioactive materials. A declaration of inactivity relieves the Authorized User from monthly swipe test requirements; however, swipe test will be required every six months for storage areas. Swipe tests are not required by inactive users if all radioactive materials have been removed and are not being stored in their areas. During periods of inactivity, the RSO will determine if the lab will need to be decommissioned.
 14. Arrange for disposal or transfer of all radioactive materials promptly upon termination of the authorized use or application ([RAS Form 7](#)) and ([RAS Form 8](#));
 15. Ensure proper security levels for sources of licensed radioactive materials, including both unsealed and sealed sources per the requirements of the Radiation Safety Program – Material Security and Loss/Theft Procedure.

V. Radioactive Materials

A. Application for Use

Authorized users desiring to use radioactive materials must submit the UNC Charlotte Application for Use ([RAS Form 1](#)) to the EHS Office. Persons desiring authorized user status must provide the RSO with a written description of his/her training and experience, which the RSO can forward to the NC RPS in a license amendment request. Students or research assistants are not usually included as authorized users on the UNC Charlotte licenses, but may work under the direction of an authorized user.

B. Processing Purchase Requisitions

The EHS Office shall review all purchase requisitions for radioactive materials to ensure the following criteria are met:

1. An authorized user of radioactive materials, as dictated by inclusion on one of the University's radioactive materials licenses, places the requisition.
2. The authorized user has been approved for the nuclide being ordered.
3. The quantity ordered by the authorized user is within their authorized radioisotope possession limit and the UNC Charlotte possession limit.
4. The requisition is accompanied by a Certification of Current Inventory ([RAS Form 3](#)).
5. A current Radioactive Materials Inventory Record ([RAS Form 6](#)) is placed on file.

C. Inventory Records

As a condition of the University radioactive materials licenses, Authorized Users must maintain accurate records of the receipt, use, transfer and disposal of radioactive materials in their possession. These records must be readily available for periodic review by EHS. Authorized Users must submit Current Radioactive Materials Inventory Records ([RAS Form 6](#)) to the EHS Office as requested.

D. Monitoring and Control

i. Survey Instruments

Suitable radiation equipment shall be available to all laboratories where radioactive materials are used or stored. These may include pancake Geiger Mueller (pan GM) detectors in labs using beta radiation emitters (i.e., C-14, S-35, Ca-45) and exposure reading meters such as ion chambers, pressurized ion chambers, or energy compensated GM detectors where exposure conditions are required to be quantified. Survey meters used for making required radiation safety measurements will be calibrated at intervals not exceeding 12 months. The EHS Office coordinates survey meter calibration.

ii. Daily Surveys

The immediate areas (e.g., bench tops) in which unsealed radioactive materials are being used will be monitored for contamination at least once daily following the use of the radioactive materials by the users in that area. The daily contamination survey is required to be performed only on the days that unsealed radioactive materials are used. These daily checks will consist of direct monitoring using portable radiation detection instruments appropriate for the radionuclides being used. If materials with H³ or Ni⁶³ are being used, metering is not necessary and wipe tests for contamination monitoring are required.

iii. Survey of Working Areas

At the completion of each experiment, the authorized user shall be responsible for recording a survey of the restricted radioactive materials use area. This formal survey frequency may be changed by EHS as warranted.

In general, no radioactive contamination will be tolerated. Exceptions to this includes certain lab surfaces, dry boxes, stainless steel trays, absorbent paper covered surfaces, or other equipment which is used frequently for radioactive material work and which will be clearly marked with the standard caution radioactive materials tape. Any contamination that is not confined to controlled surfaces shall be cleaned immediately.

Surface contamination action guidelines for all areas will be as follows:

- a. Removable (beta-gamma) 200 dpm/100 c
- b. Fixed (beta-gamma) 2,200 dpm/100 cm²

Removable activity surveys should be made of the counting equipment, the working area, the floor under the working area, the floor at the door opening, and other surfaces where contamination is more likely. The amount of removable radioactive material per 100 cm² of surface area will be determined with an appropriate instrument of known efficiency (e.g. liquid scintillation counter) as follows:

1. Wipe or smear the surface with a dry filter or soft absorbent paper, applying moderate pressure and assessing the amount of radioactive material on the wipe sample.
2. After placing the smear samples in scintillation vials, put the top on the vials and screw on tightly. Mark the top to identify the samples.
3. After collecting all samples, fill each vial with approximately 10 ml of the scintillation counting fluid, and count the samples using full-scale settings in a liquid scintillation counter. Record the results as disintegrations per minute per 100 cm² (dpm/100 cm²) and as activity (microcuries) on UNC Charlotte [RAS Form 4](#), and submit the results to the EHS Office as requested.
4. If counts indicate significant contamination, (more than the quantities show in item two above), the area shall be decontaminated and resurveyed or, if this is not possible, labeled with 'Caution Radioactive Material' tape.
5. After counting, each user shall be responsible for storing the used scintillation vials pending transfer to EHS for disposal.

iv. Sealed Source Leak Tests

Each sealed source in use containing radioactive material, other than H³, with a half-life greater than 30 days and in any form other than gas shall be tested for leakage at intervals not to exceed six months. (*Note - licensed sealed sources containing 100 microcuries or less of beta- or gamma-emitting radioactivity, and 10 microcuries or less of alpha-emitting radioactivity are exempt from the leak test requirement.*) Leak tests samples are to be collected by the EHS Office every 6 months. Records of leak tests shall be maintained in the EHS Office.

Obtain a leak test sample kit from a licensee authorized by an Agreement State or the NRC to perform leak test analyses. Follow the instructions provided by the vendor in the leak test sample kit. Upon receipt of leak test certificates, maintain in the radiation safety files.

v. Posting of Regulations

Each authorized user shall post the standard form "*Notice to Employees*" on or adjacent to the main door of any room in which radioisotopes or ionizing radiation are used.

E. General Safety Requirements

The following rules are to be followed by all persons working with licensed radioactive materials:

1. Eating, drinking and smoking are not permitted in any laboratory or room where radioactive materials are used or stored. Additionally, storage of food or drink is not allowed in laboratories posted for radioactive materials.
2. Radioactive materials shall not be used by persons with open wounds on their hands or lower arms.
3. All equipment, furniture or supplies, which might come in contact with radioactive material shall be considered potentially contaminated and shall be surveyed for contamination before being removed from the laboratory.
4. All persons shall monitor themselves with a survey meter for contamination before leaving a laboratory where unsealed sources of radioactive material are used, stored, or suspected to be present. Smear samples must be collected in lieu of survey meter monitoring following work with tritium or Ni-63.
5. All persons issued dose-monitoring badges/rings must wear them when working with licensed radioactive materials or x-ray generating devices.
6. Radioisotope solutions shall not be pipetted by mouth.
7. Protective clothing appropriate to the conditions shall be worn at all times when working with radioactive materials. Appropriate gloves and lab coats shall be the minimum protection required. No opened toedshoes are permitted in the laboratory while working with radioactive materials.
8. The area where licensed radioactive materials are used (radiation area) shall be posted with a conspicuous sign bearing the radiation symbol and the words CAUTION RADIOACTIVE MATERIALS.
9. The area should also be posted with the current version of the "Notice to Employees" sign.

F. Use of Animals and Radiation

If a proposed project includes introducing radioactive material into animals, the applicant shall state details in the application, which will include at least the following:

1. The kind and number of animals to be used (monthly or total).
2. The radionuclide to be given including quantity and method of administration to the animal.
3. The places where the animals and cages will be kept and handled.
4. Procedures for handling, monitoring, and disposal of animals.
5. Cages must be labeled radioactive until rinsed and run through a washer and tested for residual activity.

G. Radiation Exposure and Dose Limits

Personnel exposure to radiation at UNC Charlotte shall be maintained As Low As Reasonably Achievable (ALARA).

1. Occupational Dose Limits for Adults (10A NCAC 15 .1604)

No UNC Charlotte employee shall be permitted to receive a radiation dose in one calendar year in excess of:

- 5 rem total effective dose equivalent
 - 50 rem sum of the deep-dose equivalent and the committed dose equivalent to any individual organ or tissue other than the lens of the eye
 - 15 rem dose equivalent to lens of the eye
 - 50 rem shallow-dose equivalent to the skin or extremities
2. Occupational Dose Limits for Minors (10A NCAC 15 .1609)
In no case shall an individual under the age of 18 years be permitted to receive an occupational radiation dose in excess of 10 percent of the limits set forth above.
 3. Occupational Dose Limits for Declared Pregnant Woman (10A NCAC 15 .1610)
The occupational dose to a declared pregnant woman shall not exceed 0.5 rem during the pregnancy. (See Section 2.9)
 4. Dose Limits for Individual Members of the Public (10A NCAC 15 .1611)
The total effective dose equivalent to individual members of the public shall not exceed 0.1 rem in a year. The dose in any unrestricted area from external sources shall not exceed 0.002 rem in any one hour.

i. External Dose Monitoring (radiation dosimetry) (10A NCAC 15 .1614)

External dose monitoring badges/rings will be provided by the RSO to all persons who are likely to receive a radiation dose in excess of 10% of a radiation dose limit specified in Section 2.5 A.2. (above), and all persons who enter a designated *High Radiation Area*.

It shall be the responsibility of the RSO (in consultation with the authorized user) to determine which persons (students, technicians, graduate assistants) require dose monitoring badges/rings. Authorized users should contact EHS for guidance.

Each new radioactive material user shall submit an Application for Radiation Dosimetry Services ([RAS Form 2](#)). All training certification documents must accompany the RAS Form 2 for the dosimetry application to be considered.

Authorized users shall notify EHS promptly when it is necessary to remove a monitored person from the dose-monitoring program.

The EHS Office shall contract for dosimetry service in accordance with university and state purchasing regulations. Dosimeters will be obtained from a successful participant in the National Voluntary Laboratory Accreditation Program (NVLAP). Dosimetry badges and/or rings shall be exchanged at least quarterly.

When not in use, dosimeter badges/rings shall be stored in areas where they will not be exposed to licensed or registered sources of radiation. Badges/rings shall not be worn during non-occupational exposure events such as medical X-ray, dental X-rays, etc. Badges/rings should never be taken home.

Dose records shall be maintained within the EHS Office. Annual reports of exposure will be provided to each monitored person.

An ALARA goal is established at 8% of annual dose per calendar quarter. Any dose exceeding this level shall be reported to the worker, authorized user, and will be investigated by the RSO or designee.

The occupational intake of radioactive materials will be monitored and the committed effective dose equivalent assessed for individuals likely to receive an intake in excess of 10% of the applicable annual limit (ALI).

ii. Annual Limit on Intake

The occupational intake of radioactive materials will be monitored and the committed effective dose equivalent assessed for individuals likely to receive an intake in excess of 10% of the applicable annual limit (ALI).

iii. Fetal Protection Policy

This policy is established to ensure that the dose to an embryo/fetus during the entire pregnancy of a declared pregnant woman does not exceed 0.5 rem. To the extent possible, exposures shall be controlled to avoid substantial variation above a uniform monthly exposure rate to satisfy the above limit.

It is the responsibility of UNC Charlotte to inform the woman of the Fetal Protection Policy; this is accomplished by including this topic in the radiation safety training provided to all university radiation workers.

It is the fundamental responsibility of the pregnant woman to decide when or whether she will formally declare her pregnancy to the University. The University has no responsibility for providing specific fetal radiation dose precautions until a voluntary formal declaration is made in writing. The Declaration of Pregnancy Form is located in Appendix I.

The declared pregnant woman will be assigned a monthly radiation-monitoring badge for the duration of her pregnancy.

The RSO will investigate any dose exceeding 50 millirems in a month.

In addition to the 0.5 rem limit, the ALARA radiation protection policy remains in place.

iv. Bioassay Program

Routine work with licensed radioactive materials does not require monitoring for internal radiation dose unless certain conditions are met. As such, internal dose monitoring via bioassay samples will be implemented if necessary as determined by the RSO.

A determination of routine bioassay personnel monitoring needs and frequency is made by the RSO during the review of applications to use radioactive materials. The status of existing approvals is periodically reviewed. Radiation worker registrations, surveys, inventory records, and verification of radiation staff and radionuclide use limits are considered.

Baseline and subsequent routine bioassay monitoring will be conducted if any individual is working with radionuclide form/activity combinations where an intake in excess of 10 percent of the applicable ALI (s) in Table 1, Columns 1 and 2, of Appendix B of 10 CFR 20.1001 – 20.2402 is likely.

A licensed contractor laboratory specializing in bioassay service will be used should internal dose monitoring via bioassay sampling be necessary.

Bioassay results will be recorded and maintained as part of the radiation worker's overall personnel monitoring history.

a) Bioassay Radionuclide/Form/Activity Limits

Iodine (I-125, I-131)

A thyroid bioassay by external counting is required within 24 to 72 hours after working with the following limits or greater:

1. Processes in open room or bench with possible escape of iodine from vessels:
 - 1 mCi if volatile form
 - 10 mCi if bound to nonvolatile agent
2. Processes with possible escape of iodine carried out within a fume hood of adequate design, face velocity, and performance reliability:
 - 10 mCi if volatile form
 - 100 mCi if bound to nonvolatile agent

Tritium (H-3)

A Tritium bioassay program via urinalysis must be provided when working with the following limits or greater:

1. Processes in open room or bench with possible escape of Tritium from vessels:
 - 100 mCi, excluding metallic foil
 - 100 Ci Tritium gas in process vessels
2. Processes with possible escape of Tritium carried out within a fume hood of adequate design, face velocity, and performance reliability:
 - 1 Ci Tritium and Tritiated compounds, excluding metallic foil
 - 1000 Ci Tritium gas in process vessels

Additionally, during an emergency where suspected Tritium exposure is 100 mCi or higher, a urinalysis will be provided within 24 to 72 hours.

Other Radionuclides (C-14, P-32, S-35, Ca-45, Cr-51, etc.)

Urinalysis is required within 24 to 72 hours when there is suspicion that an intake in excess of 10 percent of the applicable ALI(s) in Table 1, Columns 1 and 2, of Appendix B in 10 CFR 20.1001 - 20.2402 is likely (such as after a spill event), or with routine work using volatile forms of these radionuclides in large amounts.

v. Public Dose (10A NCAC 15.1611)

The use of radioactive materials and x-ray generating devices shall be controlled to ensure compliance with the dose limits established for members of the public. They are no more than 100 mrem in a calendar year and no more than 0.002 rem in any one hour. Limiting radiation work to restricted areas and restricting access to licensed radioactive materials and registered x-ray generating devices to authorized persons ensures compliance with these limits. Radiation surveys in restricted areas as described in this Handbook further demonstrate that no members of the public receive doses exceeding the limit.

H. Waste Disposal

Radioactive waste shall be retained in the laboratory in which it is generated or in room 101 of the EHS Solvent Storage Building pending disposal. All radioactive waste shall be clearly marked and

labeled and records of waste disposal maintained (see UNC Charlotte [RAS Form7](#)). Each authorized user shall be responsible for properly segregating radioactive waste by isotope. Long and short half-life radioisotopes must not be mixed in the same waste containers.

i. Liquid Waste

All used liquid scintillation vials should be tightly capped and returned to the original shipping trays. The total activity for each radionuclide in the tray must be marked on the outside of the tray and the tray labeled "Caution Radioactive Material." Liquid scintillation vials must be segregated by radionuclide. This provides the greatest flexibility for disposal. Vials shall be stored until picked up for disposal.

Liquids other than scintillation vials shall be stored in capped and labeled appropriate containers. No radioactive waste may be discharged into the sanitary sewer. EHS will manage disposal of liquid containers.

ii. Solid Waste

Solid wastes shall be stored in covered plastic lined containers. Additional radiation shielding may be necessary for certain isotopes. EHS will manage ultimate disposal of dry waste container contents.

iii. Animal Carcasses and Waste

Procedures for handling, monitoring, and disposal of animals contaminated with radioactivity must be in place and approved under the IACUC application.

iv. Non-Disposable Materials

Material that cannot be disposed of in one of the above methods shall be stored until UNC Charlotte arranges for their disposal by a commercial firm.

I. Receiving, Transfer and/or Shipment of Radioactive Materials

i. Procedures for Receiving and Opening Radioactive Materials (10A NCAC 15.1627)

All Radioactive material shipments will be received and opened in accordance with this procedure. Radioactive material packages will be received at the following locations:

Biology Stockroom – First Floor Woodward Hall or Chemistry Stockroom – Second Floor Burson Hall.

The Biology or Chemistry Office will notify the EHS Office immediately upon receipt or immediately the next working day if received after hours. Designated trained personnel on duty shall sign for any package containing radioactive material that arrives during off duty hours. If the package appears to be damaged, immediately contact the RSO. Ask the carrier to remain at the facility until it can be determined that neither the carrier nor the vehicle is contaminated.

EHS will monitor and wipe test packages as described below.

Procedure for Opening Packages Containing Radioactive Material

1. Wear gloves to prevent hand contamination.
2. Visually inspect the package for any sign of damage (e.g. crushed or puncture). If damage is noted, stop and notify the RSO.
3. Check DOT White I, Yellow II, or Yellow III label or packing slip to determine activity of contents, and confirm that shipment does not exceed possession limits.

4. Monitor the external surfaces of a labeled package according to specifications in the following table.

Package	Contents	Survey Type	Survey Time
Labeled White I, Yellow II, Yellow III	Not Gas or Special Form Less than Type A Quantity	Contamination	As soon as practicable but not more than 3 hours after receipt of package if received during normal work hours
Not Labeled	Licensed Material	None	None
Damaged	Licensed Material	Contamination Radiation Level	As soon as practicable; not more than 3 hrs. after package receipt if received during normal work hours

5. Open the outer package (following supplier's directions if provided) and remove packing slip.
6. Open inner package to verify contents (compare requisition, packing slip and label on the bottle or other container).
7. Check integrity of the final source container (e.g. inspection for breakage of seals or vials, or loss of liquid, discoloration of packaging material, high-count rate on smear).
8. Survey the packing material and packages (300 cm² swipe areas) for contamination before discarding. If contamination is found, treat as radioactive waste. If no contamination is found, obliterate the radiation labels prior to discarding in the regular trash.
9. Reading should be less than 240 dpm / 100 cm² or 24 dpm / 100 cm² for alpha emitting radionuclides [49 CFR 173.443].
10. Prepare a radioactive material inventory record ([RAS Form 6](#)) for the material.
11. Notify the final carrier and the N.C. RPS by telephone or email when removable radioactive surface contamination or external radiation levels exceed the limits established in 10 CFR 71.87 (i) and 10 CFR 71.47, respectively.

ii. Transfer and Shipping

The transfer of radioactive materials from one laboratory, building or user to another must be accompanied by a Radioactive Material Transfer form ([RAS Form 8](#)).

Radioactive materials, including waste items, will be prepared for transport in accordance with U.S. Department of Transportation (DOT) HAZMAT regulations for Class 7 radioactive materials by EHS. Prior to offering radioactive materials for transport, the shipper must obtain a copy of a license from the recipient documenting their ability to take possession of the radioactivity under an existing NRC or Agreement State license. Any person involved in preparing packages of radioactive material for transportation will have completed DOT HAZMAT training on shipping radioactive materials. UNC Charlotte does not transport radioactive materials and will contract a licensed/permitted transportation company.

Licensed material shall not be transferred or shipped from one licensee to another without the approval of the RSO.

EHS must be contacted before a transfer between authorized users occurs through the use of a completed [RAS Form 8](#). Recipients of transferred radioactive material must be authorized to take

possession of the material. Inventory reports (RAS Form #6) that authorized users submit to EHS on a quarterly basis must be updated to show any transfers during the inventory period.

J. Incident Response and Emergency Procedures

The UNC Charlotte Risk Management, Safety, and Security Emergency Manual provides guidance to protect University personnel and property in emergency situations. This section describes incidents and emergency conditions that may involve radioactive materials or radiation exposure, and provides specific response procedures to cope with incidents and emergencies in a safe, orderly and efficient manner, protecting the personnel and facilities at UNC Charlotte.

Radiation emergencies, as applicable to UNC Charlotte, are incidents, which involve actual or suspected exposure to uncontrolled sources of radioactivity that cause or threaten to cause an external dose in excess of five (5) rem to the whole body, or gross radioactive personnel contamination resulting in ingestion, inhalation, injection, or skin absorption of radioactive material leading to comparable risk.

The following may constitute an incident or emergency:

- 1) Spills of Radioactive Liquids and Solids
- 2) Personnel injuries that may involve radioactive material contamination of the wound
- 3) High or potentially high radiation exposure to an employee or member of the general public
- 4) Fires or floods which threaten to release radioactive material to the environment or which threaten to expose emergency response personnel
- 5) Additional situations deemed pertinent by the Radiation Safety Committee or Radiation Safety Officer

i. Spills of Radioactive Liquids and Solids

Report any leak, spill, or release of radioactive material to the responsible authorized user immediately. If the authorized user is unavailable, call the Emergency Contacts:

Radiation Safety Officer - 704-687-1111

Campus Police – 911 (campus phone) or 704-687-2200

Only the authorized user, trained radiation workers in the lab or the RSO can complete leak/spill cleanups. All persons working on a leak/spill cleanup must be fully aware of the hazards posed by the particular radioactive isotope involved – consult the Nuclide Safety Data Sheet for the isotope involved in the spill for hazard/risk control requirements.

- Clear all unnecessary persons from spill area.
- Use nearest telephone for communications and avoid spreading the contamination to otherwise non-impacted areas.
- Assemble all personnel in nearby safe area until radiation surveys and personnel decontamination are completed by authorized lab personnel and the EHS Office.
- Close doors and windows and turn off air handling equipment that could lead to the spread of airborne contamination throughout the building. Keep fume hoods operating within the laboratory.
- Prevent spread of contamination from accident site. Use absorbent paper to stop or confine the spread of contaminants if it can be done safely. Decontaminate the area, starting from the perimeter

and cleaning toward the center of the spill (use mild cleaning agents such as White Vinegar, Formula 409, Fantastik or Windex). Avoid any physical contact with contaminants.

Decontamination of rooms and building shall be done under supervision of the EHS Office. See the [Laboratory Contamination Decision Tree \(Appendix II\)](#) for more information.

The EHS Office will assess the emergency event and contact the N.C. Radiation Protection Section as required by the reporting thresholds, if exceeded, as detailed in 10A NCAC 15.

ii. Personnel Injuries Involving Radioactivity

Report any injury that may involve radioactive material contamination of the wound to the responsible authorized user immediately. If the authorized user is unavailable, call the Emergency Contacts:

Radiation Safety Officer - 704-687-1111

Campus Police – 911 (campus phone) or 704-687-2200

Life-saving or first aid measures should take precedence over radiation hazards and decontamination efforts.

In the case of contaminated wounds, rinse with running water and soap. (Do not scrub contaminated skin). Cover with sterile dressing and seek medical attention at once

Please provide the following information to medical care provider:

- Radionuclide involved;
- Amount of radioactive material involved (in μCi or mCi); and
- The chemical or physical form.
- Provide Nuclide Safety Data Sheet where feasible.

The EHS Office will assess the emergency event and contact the N.C. Radiation Protection Section as required by the reporting thresholds, if exceeded, as detailed in 10A NCAC 15.

iii. Minor Fires Involving Radioactivity

Notify all persons present to vacate the area and have one individual immediately call Campus Police: Campus phone dial 911 – Non-campus phone dial 704-687-2200 to report fire as directed in the University Emergency Plan. Indicate potential for radiation contamination.

If qualified, immediately attempt to put out the fire by approved methods (i.e., fire extinguisher) if other fire hazards or radiation hazards are not present.

Once the fire is out, isolate the area to prevent the spread of possible radiation contamination. Contact the Radiation Safety Officer: Office: 704-687-1111

Survey all persons involved in combating the fire for possible radiation contamination.

Decontaminate personnel by removing contaminated clothing and flushing contaminated skin with lukewarm water, then washing with a mild soap.

In consultation with the RSO, determine a plan of decontamination and the types of protective devices and survey equipment that will be necessary to decontaminate the area.

Allow no one to return to work in the area unless approved by the RSO.

Cooperate with RSO and RSO staff (e.g., investigation of root cause, provision of bioassay samples if licensed material may have been ingested, inhaled, or absorbed through the skin).

Follow the instructions of the RSO and RSO staff (e.g., decontamination techniques, surveys, provision of bioassay samples, requested documentation).

iv. Other Emergencies Involving Radioactivity

Report any emergency incident that may involve radioactive material to the responsible authorized user immediately. If the authorized user is unavailable, call the Emergency Contacts:

Radiation Safety Officer: Office: 704-687-1111

Campus Police: Campus phone dial 911 – Non-campus phone dial 704-687-2200

In consultation with the RSO, determine a plan of decontamination and the types of protective devices and survey equipment that will be necessary to decontaminate the area.

The EHS Office will assess the emergency event and contact the N.C. Radiation Protection Section as required by the reporting thresholds, if exceeded, as detailed in 10A NCAC 15.

Follow the instructions of the RSO and RSO staff (e.g., decontamination techniques, surveys, provision of bioassay samples, requested documentation).

K. Material Security and Loss/Theft Prevention

The usage of radioactive material must be controlled at all times to prevent unauthorized use or theft.

- All radioactive materials must be securely locked when not in use. This includes the locking of laboratory doors or storage containers, etc.
- Constant surveillance and control must be maintained while radioactive materials are in use. The authorized user or designee must be in the laboratory or surrounding area at all times, where he or she is in position to monitor for unauthorized access.
- This requirement applies to radioactive material in waste and experiments in progress, as well as stock solutions. There is no exempt quantity of radioactive material that eliminates this level of security.
- Radioactive material must be stored or used within designated areas of laboratories in accordance with the authorized user's approval.
- All machines that contain radioactive sealed sources, such as gas chromatographs (if equipped with an electron capture detector - ECD), and liquid scintillation counters must be kept secure at all times. Change of use and/or storage location must not be initiated without first notifying and receipt of approval from the EHS Office. Additionally, if these machines are to be transferred or otherwise removed from campus, the RSO must be notified immediately so the proper tracking and recordkeeping can be completed. The sealed radioactive sources may not be removed or tampered with.

Loss or theft of radioactive material requires the immediate notification to the Police and Public Safety Department at (704) 687-2200 and the EHS Office at (704) 687-1111. Provide the following information:

- Radioisotope
- Chemical and physical form
- Isotope ID# (assigned by the EHS Office)
- Quantity (activity)
- Location from which the radioactive material is missing
- Authorized user's name
- Person reporting the loss/theft
- Date and time the radioactive material was discovered to be missing

The EHS Office and RSO will determine the extent of hazard presented by the possible loss/theft of radioactive material. Dependent upon the loss/theft risk level to the public health, the EHS Office will coordinate appropriate action with Police and Public Safety, Vice Chancellor for Business Affairs, Associate Vice Chancellor for Safety and Security and the Radiation Safety Committee.

The EHS Office will report the loss or theft of Radioactive Materials to N.C. Radiation Protection Section in accordance with 10A NCAC 15.

Any loss or suspected theft must be thoroughly investigated and documented. The incident report and supporting documentation will be placed in the radiation safety file for recordkeeping purposes.

L. Program Review

EHS or a third-party reviewer will review the radiation protection program content and implementation at a minimum on an annual basis. Records of these reviews shall be maintained by EHS for a minimum of three years following the review. Results of the review shall be documented in a written report.

M. Inspections – Radioactive Materials

Authorized user laboratories will be inspected by EHS. The inspection will examine the areas detailed in [RAS Form 11](#) – Radioactive Materials Authorized User Inspection Record. After completion of the inspection, EHS will provide an inspection report to the authorized user outlining any deficiencies and required corrective actions. The authorized user is required to send a written email reply to EHS with follow up actions within 30 working days.

VI. Radiation Producing Machines

A. Application for Use

All persons desiring to purchase or use ionizing radiation producing machines or devices must submit the UNC-Charlotte RAS Form #9 to the EHS Office. Use of these machines or devices must be in conformity with all applicable requirements of the *North Carolina Regulations for Protection Against Radiation* which are designated to minimize external radiation exposure hazards arising from the use of such equipment.

Ionizing radiation producing devices are those which emit ionizing radiation. Devices which produce X-rays as an operational by-product such as electron microscopes are included.

B. Monitoring and Control

Restricted areas with radiation producing machines will be posted with the North Carolina “Notice to Employees” – current revision.

All machines or devices shall be labeled in a manner which cautions individuals that radiation is produced when the machine is operated.

Radiation producing machine surveys must be completed each month that the machine is actively utilized and documented on [RAS Form 13](#).

[RAS Form 10](#) utilization logs must be maintained and available for inspection by EHS and the NC RPS.

Equipment operating above 150 kVp shall have a control station within a protective booth or outside the treatment room. Labels and warning lights on X-ray generating devices should be legible and left in place.

C. Personnel Safety

i. Limits of Exposure

No exposed person area shall be permitted to receive a radiation dose in one calendar year in excess of those listed in Section V.G. of this Handbook.

In no case shall an individual under the age 18 years be permitted to receive an occupational radiation dose in excess of 10 percent of the annual limits established for adult radiationworkers.

The occupational exposure of a declared pregnant woman shall not exceed 0.5 rem during the pregnancy. See Section V.G.iii for the fetal protection policy.

ii. Dosimeter Badges

All persons working on or near X-ray machines while in use are required to wear dosimeter badges. Submit UNC Charlotte [RAS Form 2](#) to the EHS Office to obtain this service.

iii. General Safety Rules

Safety glasses, personal eyeglasses or other appropriate eye protection devices shall be worn at all times when working with low energy output X-ray apparatus.

Follow all safety requirements outlined in the appropriate X-ray device-operating manual. If you have any questions or reservations about how to properly operate the machine and minimize risk, contact the authorized user of the X-ray device before using the machine.

Port closures should be double-checked before moving the beam stop, collimator on the main body of an instrument, or changing a specimen.

Persons should be especially careful about keeping their fingers out of the primary beam, especially when making adjustments on goniometer heads. It is often best to keep one's hands on the X-ray tube side of the goniometer to prevent any part of the hand from drifting, unnoticed, into the beam.

When changing the equipment configuration or equipment alignment relative to an energized X-ray tube, the radiation field shall be continuously monitored with a survey meter and the survey recorded on the RAS #13 survey form.

D. Inspections – X-ray

Authorized user laboratories will be inspected by EHS. The inspection will examine the areas detailed in [RAS Form 14](#) – X-ray Authorized User Inspection Record. After completion of the inspection, EHS will provide an inspection report to the authorized user outlining any deficiencies and required corrective actions. The authorized user is required to send a written email reply to EHS with follow up actions within 30 working days.

Areas covered in the inspection:

- 1) Training records available and current for authorized operators;
- 2) Operating procedures available for startup, shutdown, steady state operations, and Emergencies
- 3) Application for the use of radiation producing machines ([RAS 9](#)) complete;
- 4) Label – “Caution High Intensity X-Ray Beam” near beam exit port;
- 5) Label – “Caution – Radiation – This Equipment Produces Radiation When Energized” near switch;
- 6) Warning lights present and functioning labeled “X-Ray On” near switch and visible from all access areas when energized;
- 7) Monthly survey reports available and documented on [RAS From 13](#)
- 8) Survey reports available and documented for initial installation, following any change, and following maintenance
- 9) Lab posted with “Caution – X-Ray equipment” and current version of Notice to Employees
- 10) Standard Operating and Emergency procedures posted.
- 11) Survey meter calibrated within the last year and available to the laboratory.
- 12) Instrument utilization available, current, and documented on [RAS Form 10](#).
- 13) On open beam configurations, an easily discernable warning device that gives indication of tube, shutter, or beam status near each port on the radiation source housing.
- 14) Security of equipment maintained
- 15) Personnel dosimetry used appropriately and records available.
- 16) Proper use of personal protective equipment (lab coats, gloves, safety glasses).

VII. Training

A. Radiation Material Authorized Users and Workers

Radioactive Materials (RAM) Authorized Users and Radiation Workers wishing to obtain approval to work with radioactive materials must notify the EHS Office. The applicant will be provided with a “RAM New User Packet” that details the training required in order to be approved by the University to use radioactive materials. At a minimum all Authorized Users and Workers must complete Online Radionuclide Safety training course. In addition, to the Online Radionuclide Safety training course, AU must provide laboratory specific training to radiation workers.

The training provided shall be documented on the laboratory specific training documentation memo or other method. Copies of laboratory specific training documentation should be returned to the EHS Office.

Laboratory Specific Training Documentation Memo Example:

USE OF RADIOACTIVITY IN THE LABORATORY OF Insert AU Name

DEPARTMENT OF Insert Department Name

UNIVERSITY OF NORTH CAROLINA AT CHARLOTTE

This memo is to document the training of individuals in the hazards and precautions for the use of radioactivity in the laboratory of ***Insert AU Name***. Specifically, laboratory personnel have read and are aware of the hazards and precautions when using ***Insert radioactive material name*** as indicated on the Nuclide Safety Data Sheets and agree to follow the safety requirements detailed therein.

Additionally, radiation workers are aware of the UNC Charlotte:

- 1) Nuclide Safety Data Sheet/s for the radioactive material you will be using;
- 2) The UNC Charlotte Handbook for Radiation Safety;
- 3) Any specific radioisotope usage procedures that the PI/Authorized User has in place for RAM usage;
- 4) Emergency Procedures including the Laboratory Contamination Decision Tree and Responding to Radioactive Material Spills in the Laboratory;
- 5) Material Security and Loss/Theft Procedure;
- 6) If applicable, a review of the “Fetal protection policy”

(Radiation Worker Name and Date) _____

Refresher training for Authorized Users and Radiation Workers actively working with radioactive materials should be completed every 3 years at a minimum. Refresher training can also be accomplished through the online training program detailed above.

Radiation workers are not permitted to proceed with radioactive material work until all training has been completed.

A list of Nuclide Safety Data Sheets is located in Appendix III. The appropriate sheet is to be reviewed for each isotope in use in the laboratory prior to a beginning work.

B. X-Ray Radiation Authorized Users and Workers

X-Ray Authorized Users and Radiation Workers wishing to obtain approval to work with x-ray devices must notify the EHS Office. The applicant will be provided with a “X-Ray New User Packet” that details the training required in order to be approved by the University to use X-Ray devices. At a minimum all Authorized Users and Workers must complete Online Radiation Safety - Radiation Producing Devices Safety training course. In addition, to the Online Radiation Safety - Radiation Producing Devices Safety training course, AU must provide laboratory specific training to X-Ray radiation workers.

The training provided shall be documented on the laboratory specific training documentation memo or other method. Copies of laboratory specific training documentation should be returned to the EHS Office:

Laboratory Specific Training Documentation Memo Example:

USE OF X-RAY DEVICE IN THE LABORATORY OF *Insert AU Name*

DEPARTMENT OF Insert Department Name
UNIVERSITY OF NORTH CAROLINA AT CHARLOTTE

This memo is to document the training of individuals in the hazards and precautions for the use of radioactivity in the laboratory of Insert AU Name. Specifically, laboratory personnel have read and are aware of the hazards and precautions when using Insert x-ray device name as indicated on the X-Ray device and agree to follow the safety requirements detailed therein.

Additionally, radiation workers are aware of the UNC Charlotte:

- Understanding the x-ray diffraction, spectroscopic, or radiographic techniques used by the machine;
- Overall operation of the x-ray machine (Operational Manual review);
- X-ray warning lights;
- Emergency shut-off procedure;
- Use of whole body and ring badge dosimetry;
- Use of radiation shields and shutters, if applicable by unit;
- Use of radiation survey meters;
- Recordkeeping.

(Radiation Worker Name and Date) _____

VIII. Enforcement

As described in Section 2.4 B, each laboratory using radiation sources is assigned an inspection frequency by EHS based on a variety of factors, including the type and amount of radiation used and the experimental techniques employed. At the discretion of the EHS Office, the assigned inspection frequency of any laboratory may be changed to reflect the appropriate level of surveillance.

Corrective Actions for Violations

As part of EHS inspections, items ranging from ambient radiation levels to observance of prudent laboratory safety practices are evaluated. Any radiation safety violations observed during a routine inspection are documented in an inspection report, and a formal set of steps are initiated to correct the problems. The procedure that is used to correct radiation safety violations involves a series of notifications:

Step One: If, during any routine inspection of a radiation laboratory, a problem involving radiation safety is found, the technician staff will be notified. The observed deficiency will be recorded on the inspection report form which is provided to the authorized user for the laboratory and copied to the Department Chair. Upon receipt of this inspection report, the authorized user will be charged to take the necessary steps to correct the problem. A written response detailing how the problem was addressed is required from the authorized user within 30 working days from the date of the inspection.

Step Two: If within a six month period, a second inspection reveals that the same problem(s) exists, notification of this situation will be sent to both the authorized user and the Department Chair. No further orders of radioactive material will be placed for the authorized user until the EHS Office receives a written response concerning the item. This response shall include the specific steps taken to ensure that the problem does not reoccur. For users of X-ray producing machines, steps may be taken to lock out the machine until the EHS Office receives a written response addressing the item.

Step Three: If within a new six month period, a third inspection indicates a persistence of the problem, both the authorized user and the Department Chair will be given a final written account of the situation. The EHS Office will place no orders for radioactive material for the authorized user, and procedures will be initiated to remove existing inventories of radioactive materials. For users of X-ray machines, steps may be taken to revoke the authorized use of the machine from the University registration.

The EHS Office without regard to disciplinary procedures will suspend any operation causing an excessive radiation hazard immediately dangerous to personnel immediately. Such hazards include intentionally exposing personnel to unshielded radiation or defeating interlocks.

APPENDICES

Appendix I



Environmental Health and Safety

Declaration of Pregnancy Form

The North Carolina Regulations for Protection Against Radiation (10A NCAC 15, Section .1610) requires that the dose to an embryo/fetus during the entire pregnancy of a declared pregnant woman not exceed 0.5 rem due to occupational exposures.

This limit is one-tenth the annual limit for occupational exposure. To enact this limit, it is required that female radiation workers formally notify the University of pregnancy in writing.

Please complete the section below and return to the Environmental Health and Safety Office if you choose to make this voluntary notification.

Otherwise please indicate that you have reviewed this information by completing the last section and return to the Environmental Health and Safety Office.

I understand that it is the fundamental responsibility of the pregnant woman to decide when or whether she will formally declare her pregnancy to the University. I hereby choose to make this formal notification.

Signature: _____ Date: _____

Name (please print): _____

Estimated date of conception: _____

Expected delivery date: _____

I have reviewed a copy of the NRC Regulatory Guide 8.13 and the UNC Charlotte Fetal Protection Policy.

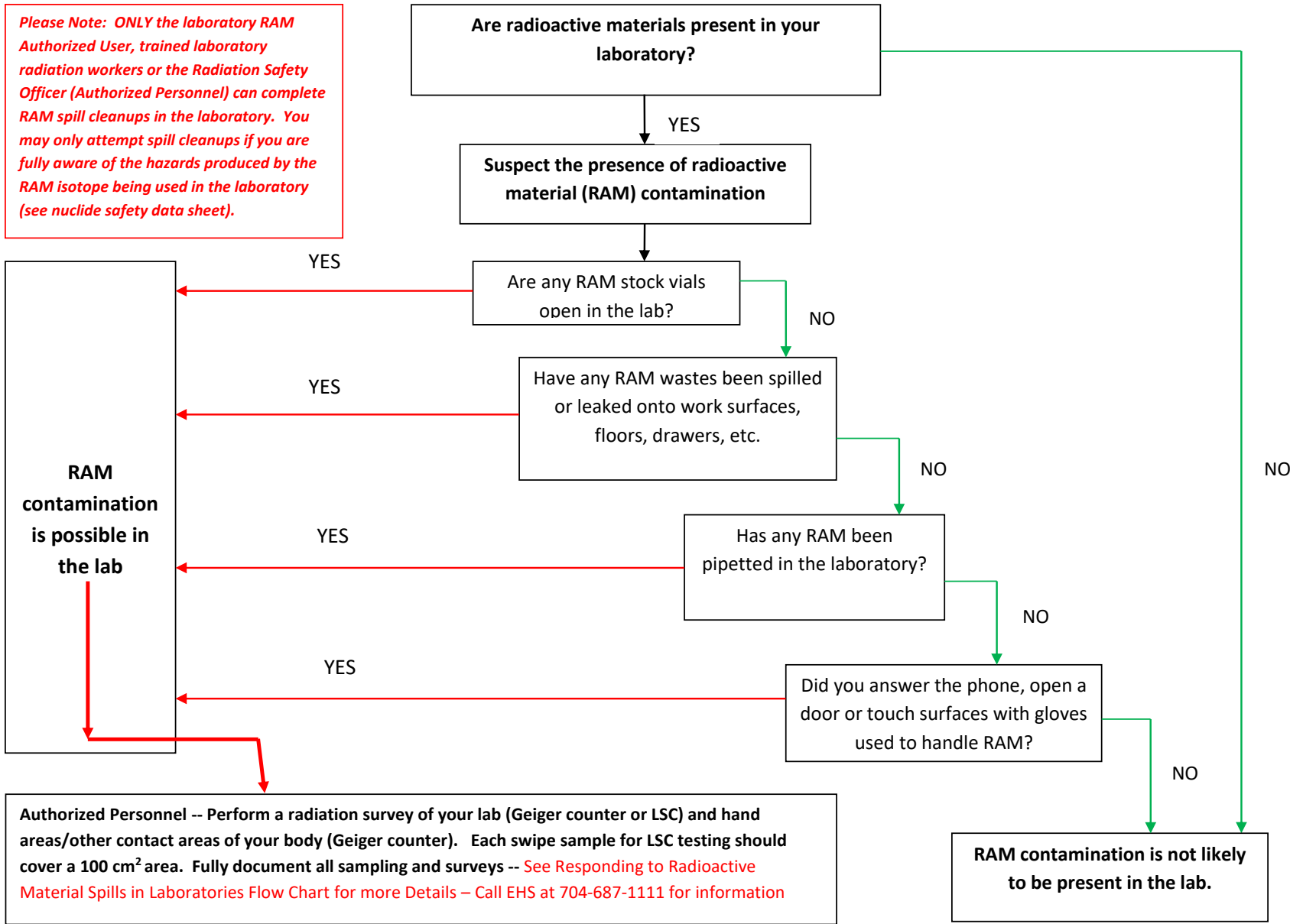
Signature: _____ Date: _____

Name (please print): _____

Appendix II

Radiation Safety Program – Laboratory Contamination Decision Tree

Please Note: ONLY the laboratory RAM Authorized User, trained laboratory radiation workers or the Radiation Safety Officer (Authorized Personnel) can complete RAM spill cleanups in the laboratory. You may only attempt spill cleanups if you are fully aware of the hazards produced by the RAM isotope being used in the laboratory (see nuclide safety data sheet).



Authorized Personnel -- Perform a radiation survey of your lab (Geiger counter or LSC) and hand areas/other contact areas of your body (Geiger counter). Each swipe sample for LSC testing should cover a 100 cm² area. Fully document all sampling and surveys -- See Responding to Radioactive Material Spills in Laboratories Flow Chart for more Details – Call EHS at 704-687-1111 for information

Appendix III

Nuclide Safety Data Sheets

<u>RADIOISOTOPES -- NUCLIDE SAFETY DATA SHEETS</u>
<u>Hydrogen - 3</u>
<u>Carbon - 14</u>
<u>Cesium - 137</u>
<u>Phosphorus - 32</u>
<u>Phosphorus - 33</u>
<u>Sulfur - 35</u>
<u>Chromium - 51</u>
<u>Iodine -125</u>
<u>Iodine -131</u>
<u>Nickel - 63</u>

