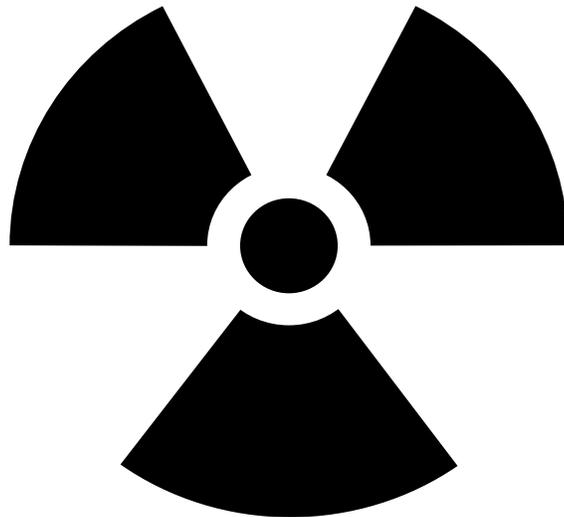


Radiation Safety Manual

For Authorized Users and Radiation Workers



Environment, Health and Safety
University of North Carolina at Chapel Hill
962-5507

**RADIATION SAFETY MANUAL
FOR AUTHORIZED USERS AND RADIATION WORKERS**

Radiation Safety Office

Environment, Health and Safety

University of North Carolina at Chapel Hill

REVISED: April 2009

This manual is available for downloading at www.ehs.unc.edu.

EMERGENCY TELEPHONE NUMBERS

	Phone	Hours
Environment, Health and Safety	962-5507*	8:00 am-5:00 pm
Radiation Safety Officer	962- 5507	8:00 am-5:00 pm
Pager (24 hour operation)	216-2311	
University Police	911	24 Hours
Fire or Smoke	911	24 Hours
Medical Emergencies	911	24 Hours
North Carolina Poison Control Center	1-800-672-1697	24 Hours

*The Environment, Health and Safety Specialists wear pagers and can be reached after hours through University Police.

SPECIAL INCIDENT REPORTING:

	Work Hours	After-hours
Radiation Safety Incidents or Safety Questions	EHS 962-5507	Univ. Police 911
Gas Leaks or Odors	EHS 962-5507	Univ. Police 911
Chemical Spills	EHS 962-5507	Univ. Police 911

Revised: April 2009

PREFACE

The University of North Carolina at Chapel Hill strives to provide a safe and healthful environment for all persons associated with the University, including faculty, staff, students, visitors, and members of the Chapel Hill community. Attainment of this goal requires cooperation and commitment on the part of us all.

The University emphasizes safety education and training as primary means of achieving this goal. While the Environment, Health and Safety, the department primarily responsible for health and safety functions at the University, performs various periodic inspections, department heads, faculty members, and supervisors are considered directly responsible for maintaining full compliance with University safety policies and procedures.

With regard to radiation safety matters, the Radiation Safety Committee, appointed by the Chancellor, formulates radiation policies and procedures. Responsibility for carrying out these policies and procedures rests with the Radiation Safety Officer who directs the Radiation Safety Section of the Environment, Health and Safety Department.

The elements of the University's radiation safety program are presented in this Radiation Safety Manual. The safety program has been carefully developed to assist all radiation users in utilizing the unique advantages of radiation sources while meeting their safety responsibilities in as efficient a manner as possible. In addition, radiation safety philosophy includes an objective of maintaining all exposures at levels as far below specified limits as can reasonably be achieved. The University strongly supports this "As Low As Reasonably Achievable" safety goal. The policies and procedures found in this manual promote and ensure the routine achievement of this goal.

In this era of increasing concern for occupational safety and for the environment, it is essential that all members of the University community become and remain thoroughly familiar with their responsibilities for compliance with health and safety regulations, including these radiation safety policies and procedures. Study the contents of this manual. Know and practice these, and all other, safety rules. Thank you for your cooperation.

H. Holden Thorp, Chancellor

Revised: April 2009

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CHAPTER ONE

UNC-CH RADIATION SAFETY PROGRAM

Introduction:

The University of North Carolina at Chapel Hill has been authorized by the State of North Carolina Department of Environment and Natural Resources, Radiation Protection Section, to use radiation sources in operations, education, research and development activities. The UNC-CH Radiation Safety Committee may authorize individual faculty members, as Authorized Users, to use radiation sources after a review of the proposed use, adequacy of facilities, and experience of the applicant. Although this provision allows the University great flexibility in dealing with the multitude of radiation sources and research uses encountered on campus, it places equally great responsibility on investigators and the administration to comply with State regulations so that this flexibility may continue.

This manual summarizes the terms of the University's authorization and the regulations most applicable to campus utilization of various radiation sources. A copy must be available for each Authorized User's facility where radiation sources are used. Special precautions, regulations, and other operating procedures specified by the Radiation Safety Committee or Radiation Safety Officer as a condition for approval of radiation source authorization must also be maintained and made available to laboratory personnel and EHS Safety officers.

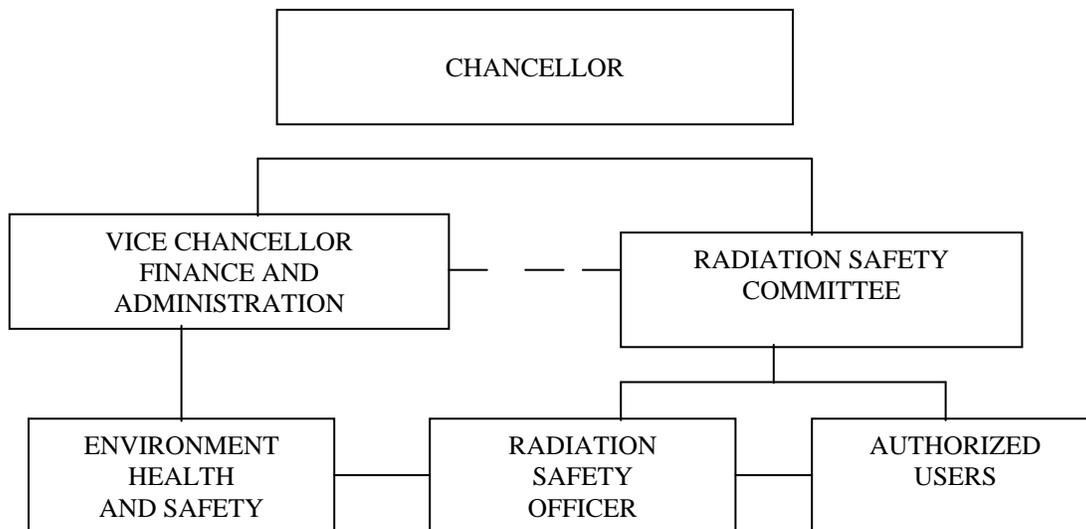
Everyone involved with the use of radiation sources in any way is required to be familiar with the provisions of this manual. The manual must be readily available to all interested individuals. All radiation exposure must be maintained to levels that are as low as are reasonably achievable (ALARA).

Responsibilities:

The Radiation Safety Committee is responsible for establishing policies governing the procurement, use, storage and disposal of radioactive materials and radiation-producing devices. The Committee includes individuals experienced in the use or application of radioactive materials and radiation devices and provides a peer review of these uses among researchers at the University. The Committee meets, at least quarterly, to review reports on the receipt and disposal of radioactive materials/radiation-producing devices, and to act on applications for authorization to use these sources. The Committee, along with its Chairman, is appointed by the Chancellor. It makes an annual report of activities to the Vice Chancellor for Finance and Administration.

The Department of Environment, Health and Safety (EHS) has the administrative responsibility for the University's Radiation Safety program. The EHS staff provides a wide range of radiation protection services such as personnel monitoring, waste disposal, laboratory surveys, instrumentation calibrations, maintenance of records required by the State, and consultation on the safe use of radiation sources.

UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL



**Organizational Chart for the Authorization
To Use Radiation Sources**

The Radiation Safety Officer is responsible for radiation protection on this campus, including general surveillance of overall activities involving radiation sources and all areas where sources are used; determining compliance with rules and regulations, authorization conditions and the conditions of project approval specified by the Radiation Safety Committee; consulting on radiation protection with University staff; determining the need for and evaluation of personnel monitoring; conduction of training programs and otherwise instructing personnel in the proper procedures for the safe use of radiation sources; and immediately terminating any project that is found to be a threat to health or property.

All applications for radiation source use, location, procedures, and possession limit changes are reviewed by the Radiation Safety Officer. The Radiation Safety Officer may grant limited interim approval of those applications satisfying all appropriate requirements. The Radiation Safety Officer recommends final action on applications to the Radiation Safety Committee.

Radiation safety courses are given by the Radiation Safety Office every month for employees who will begin working with radiation sources. A schedule may be obtained from EHS. Other specialized training and consultation can also be arranged by appointment.

An Authorized User (AU) is a faculty member who has been approved to use radiation sources according to the procedures developed by the Radiation Safety Committee. The Authorized User will normally be the principal investigator of a research project involving radiation sources or the faculty member responsible for a course with laboratory or field exercises in which sources are used. Although faculty members may use radiation sources under another faculty member's authorization, each faculty member is encouraged to obtain his/her own authorization. It is the Authorized User's responsibility to insure that students and staff using radiation sources under his/her authorization are trained in safe laboratory practices, are familiar with the terms of the authorization and do, in fact, comply with University policies and applicable regulations.

Request for Special Safety Investigation:

The North Carolina Radiation Protection Section makes provisions for employees to request an inspection or evaluation of conditions that they believe may constitute a health or safety hazard. University employees are encouraged to report such conditions to EHS and to request a "Special Investigation" into the need for corrective action. University employees who are aware of a health hazard or unsafe condition should notify EHS, 1120 Estes Drive Extension, CB# 1650, or call 962-5507. Employees are encouraged to seek resolution of a hazardous condition through EHS. A person requesting an inspection by EHS or the NC Radiation Protection Section may request confidentiality and by law, his/her name will not appear on any record published, released, or made available to the public, to his/her immediate supervisor, or department head.

After EHS has concluded its investigation, the results will be communicated, in writing, to the party requesting the investigation and to other appropriate University personnel with due consideration of requests for anonymity. If it is determined that there are reasonable grounds to believe that violation or danger exist, corrective action will be initiated. If corrective action cannot be implemented within a reasonable period EHS may terminate the operations until corrective action is taken.

CHAPTER TWO

RADIATION SOURCE AUTHORIZATION AND RADIATION WORKER REGISTRATION

Procedure for Obtaining Authorization to Use Radiation Sources:

To obtain authorization to procure and use radiation sources, a prospective Authorized User must complete and submit applicable Schedules of the Laboratory Safety Plan (<http://ehs.unc.edu/ih/lab/lsp.shtml>). For help in completing the radioactive materials portion of the Laboratory safety Plan, please reference “Characteristics of Commonly Used Radionuclides” at <http://ehs.unc.edu/ehs/forms.shtml#rad>. The Radiation Safety Officer will review the plan and schedule an interview with the prospective user to evaluate the facilities available, the training and experience of the applicant and staff for the proposed use, and the details of the work to be performed.

The procedures described in the application, as modified by the Radiation Safety Officer and/or the Radiation Safety Committee, become the conditions under which the researcher and his/her personnel are authorized to use radiation sources. Any subsequent change in procedure regarding the use, storage or disposal of sources must be reviewed by the Radiation Safety Officer prior to instituting the change.

- Facilities Evaluation:

The review of radiation source use applications will include a review of the adequacy of the proposed facilities. Depending on the quantity of material involved, the type of source and the complexity of the proposed procedures, the following will be considered:

1. Isolation from general laboratories and public areas.
2. Availability of radiation detection instrumentation.
3. Adequacy of ventilation and fume hoods.
4. Readily cleanable work surfaces and floors.
5. Provisions for shielding and secure storage of sources

- Radiation Worker Registration:

To provide the University with a record of the training and experience of persons working with radiation sources, Worker Registration Form (<http://ehs.unc.edu/ehs/forms.shtml#rad>) is to be completed and submitted to EHS. The Radiation Safety Office will review the registration form and schedule necessary training sessions. EHS is to be informed of all changes in personnel working with radiation sources. An updated Worker Registration Form must be provided when personnel transfers, additions, or deletions occur.

A copy of the approved registration form reviewed by Radiation Safety should be printed from the on-line application by the Authorized User. This copy must be maintained in the Authorized User's radiation safety records. The original form is kept at the EHS office. Radiation Worker Registration forms must be maintained by the Authorized User and EHS as long as the individual's employment actively involves the use of radiation sources. Upon termination or transfer, the form may be archived or removed from the records after a three year time period has elapsed. Inactive forms should be maintained in a separate section in the radiation safety records.

- Posting Requirements:

All rooms authorized for radioactive materials use, storage or disposal must be posted with copies of pages 11 and 20 of this Manual and the Radiation Safety Security Procedures. Page 11 presents the radiation safety rules to be followed when using radioactive materials. Page 20 presents the radiation emergency procedures for responding to incidents. The Radiation Safety Security Procedures (found at <http://ehs.unc.edu/ehs/forms.shtml#rad>) provides information on the proper security of radiation sources/radioactive waste and the steps to follow in case of suspected loss of radioactive materials to municipal waste streams. This form includes a section for listing the Housekeeping supervisor for an Authorized User's building. In case of a radiation source loss, the building supervisor must be informed as soon as possible to stop any waste removal from the building.

A copy of the North Carolina Radiation Protection Section's Form, "Notice To Employee" must be posted in each authorized room. This posting provides required information on the employer / employee's rights and responsibilities as radiation workers and can be found at <http://ehs.unc.edu/ehs/forms.shtml#rad>.

- Ventilation Hoods:

The use of volatile materials and other conditions requires the use of a properly designed and operating ventilation hood. The exhaust airflow provided by a hood creates a margin of safety from the accidental inhalation of chemical and radioactive fumes and gases. A minimum hood face velocity air flow of 100 linear feet per minute with an 18 inch sash opening is required for radioactive materials use hoods.

EHS measures the face velocity of all hoods annually. Any deficiencies are noted and referred to the UNC Facility Services for correction. Hoods should not be used for storage. Items in a hood will impede and disturb the exhaust airflow and potentially reduce or eliminate the safety factor. Exceptions may be granted for volatile wastes or certain other approved circumstances.

CHAPTER THREE

RADIATION PROTECTION PRINCIPLES

Types of Radiation Dose:

The body may be irradiated in two general ways; externally from radioactive material or radiation sources, or internally from radioactive material deposited in the body.

External doses can be the result of exposure to gamma, x-ray, or high-energy beta emitters. Low energy beta and alpha emitters lack the energy needed to penetrate the outer layer of skin and subsequently present less of an external hazard, and are of more concern when ingested. The radiation dose an individual receives depends on the following factors:

Exposure: The "strength" (activity, mrem/hr, etc.) of the radiation source. By reducing the amount of radioactive material used or lowering the settings on a radiation-producing machine, dose can be reduced.

Time: The total dose received from an external source is dependent on the amount of time actually exposed to the source. Therefore, any time that is spent near a source should be controlled, and used effectively.

Distance: By increasing the distance between the source of exposure and an individual, the dose received can be significantly reduced. When an individual doubles his/her distance from a gamma source, for example, the dose rate at the further distance will drop to one-fourth of the level at the closer distance.

Shielding: When radiation sources are being used, absorbing material or shields can be incorporated to reduce exposure levels. The specific shielding material and thickness is dependent on the amount and type of radiation involved.

Internal exposure results from the absorption, ingestion or inhalation of radioactive material. This material can be incorporated in the body in several ways:

- Breathing radioactive gases, vapors or dust.
- Consuming radioactive material transferred from contaminated hands, tobacco products, food, or drink.
- Entering through a wound.
- Absorption through the skin.

The fundamental objectives of radiation protection measures are:

To limit exposure from external radiation to levels that are as low as reasonably achievable and always within the established dose limits.

To limit entry of radionuclides into the human body via ingestion, inhalation, absorption, or through open wounds when unconfined radioactive material is handled, to quantities as low as reasonably achievable and always within the established limits.

When these objectives have been met, it is practicable to use radiation sources for academic, development, research and clinical procedures.

General Radiation Safety Guides for Radioactive Material Use:

1. The procedure for each project should be well outlined in writing for all laboratory personnel. Necessary equipment, waste containers, and survey instruments must be available.
2. Characteristics of the radioactive material such as type of radiation, energy, half-life, significant and typical amounts, and chemical form should be known.
3. In some cases, before the procedure is actually performed with radioactive material, a "dry run" practice of the procedure may be useful to avoid problems.
4. A radiation worker should supervise visitors and students in a laboratory that uses radioactive material.
5. Radioactive material must not be left unattended in places where it may be handled or removed by unknowing and unauthorized persons. All lab rooms and waste storage areas must be locked when unattended.
6. As a general practice, work with radioactive material should be confined to only the areas necessary. This simplifies the problem of confinement and shielding, and aids in limiting the affected area in case of an accident.
7. All work surfaces and storage areas (tabletops, hoods, floors, etc.) should be properly covered. Some facilities, especially in older buildings, are very difficult to decontaminate.
8. Absorbent mats or paper should be used. Protective absorbent with a plastic back and absorbent front is especially useful. If contaminated, it can simply be discarded in the radioactive waste container.
9. Plastic or metal trays (stainless steel washes easily) should be placed on the surface when liquids are to be used. The tray serves to confine a spill.
10. Good housekeeping must be practiced at all times. If an area is kept neat, clean, and free from equipment not required for the immediate procedure, the likelihood of accidental contamination or unnecessary exposure is reduced.
11. Radioactive material, especially liquids, should be kept in unbreakable containers whenever possible. If glass is used, a secondary container must be provided.
12. NEVER PIPETTE BY MOUTH SUCTION! Always use a mechanical pipette filling device.
13. Eating, drinking, smoking, application of cosmetics, or storing of food is prohibited except in specifically defined and posted food item areas. See the Food Area Policy and Procedure, page 9, for details. Food areas, including desks and tables, must be included in the monthly radiation survey.
14. Refrigerators used to store radioactive material shall not be used for the storage of food. All storage compartments (refrigerator and freezer sections) must be conspicuously posted with radiation warning stickers.
15. Refrigerators used for food storage must be posted as "FOOD STORAGE AREA - NO HAZARDOUS SUBSTANCES ALLOWED." These appliances must be included in the monthly radiation survey.
16. Smoking is not permitted in areas where work with unsealed radioactive sources is in progress or where contamination may exist. Under no circumstances should cigarettes, cigars, or pipes be laid on tables or benches where radioactive work has been performed or is in progress.
17. Wash hands thoroughly after working with or near radioactive materials and before eating, drinking, smoking, or applying cosmetics.

18. Protective gloves must be worn any time an unsealed radiation source is being used. Do not use the telephone, handle books, open cabinets, or the like with contaminated gloves. If there is a break in the skin on the hand, be sure to wear gloves.

19. Lab coats and appropriate shoes must be worn by all individuals handling radioactive material.

20. All reusable glassware and tools used with radioactive material should be thoroughly cleaned after use and kept separate from non-contaminated items. It is recommended that a marked container or area be provided for glassware and tools used in radioactive work.

Eating, Drinking and Smoking Policy

Contamination of food, drink, tobacco products, and cosmetics is a potential route for ingestion of a hazardous substance. Food is to be stored, handled and consumed in an area free of hazardous substances. Non-laboratory areas (i.e., nearby break rooms, lounges or conference rooms) are to be designated as food storage and eating areas for laboratory personnel. When these activities occur in laboratories there must be a clear separation from laboratory operations that involve hazardous materials in order to minimize the possibility of contamination in food areas. Areas where food is permitted must be prominently designated and posted with a warning sign (e.g., DESIGNATED FOOD AREA – HAZARDOUS MATERIALS NOT PERMITTED). Smoking is strictly prohibited in University buildings.

When food areas are established in laboratories, the following rules are to be observed:

1. Well-defined, fully outlined food item areas (including desks, cabinets, microwaves and refrigerators) must be established when food items are permitted in labs.
2. Food item areas are to be clearly posted with a sign designating a food item area and instructing that no radioactive, chemical or infectious materials are permitted.
3. Food item areas must be at least three feet from a laboratory work area or chemical storage area. In some instances, food items areas may be less than three feet if an appropriate barrier is in place, but these cases must be evaluated by EHS. In other cases, three feet may be inadequate to prevent contamination of food items, i.e., laboratory operations with a high potential for aerosolization and volatilization of chemicals or radioactive materials. Food areas are not permitted in rooms with such operations. The design of some laboratories may not allow for the designation of food areas.
4. Food containers, dishes, and utensils are to be washed only in a sink exclusively designated for food utensils. Laboratory glassware or equipment are to be washed in separate sinks. Glassware or utensils that have been used for laboratory operations cannot be used for food or beverages.
5. Laboratory refrigerators, ice chests, and cold rooms cannot be used for food storage. Separate equipment must be dedicated for that use and be prominently labeled.
6. Designated food item areas must be free from all research-related items including personal protective equipment.
7. Absolutely no chemical or radioactive materials storage is allowed above any designated food items area.

General Radiation Safety Guides for Use of Radiation Producing Machines:

1. Each individual intending to operate any radiation producing machine must be trained in its use by an individual familiar with the system.
2. Each individual working with a radiation machine should know exactly what work is to be done and which applicable safety precautions should be used.
3. Written operating and safety procedures must be available to personnel before operating this type of machine.
4. Visitors and students in the area of work should be supervised by the equipment operator.
5. Radiation producing machines must not be left unattended in an operational mode.
6. Structural shielding requirements for any new installation, or any modifications to an existing unit or room, must be approved by Radiation Safety before the machine is used.
7. When the safe use of the equipment depends on the mechanical set up of the unit or on technique factors, these restrictions should be closely followed.
8. Under no circumstances shall shutter mechanisms or interlocks be defeated or in any way modified except in accordance with approved written procedures.
9. All warning lights should be "fail safe" (specific regulations require "fail safe" features).
10. A manually reset cumulative timing device should be used to indicate elapsed time and to turn off the machine when the total exposure reaches the planned amount.
11. Special care is needed when working with x-ray diffraction units. Exposure rates in the primary beam can be in excess of 500,000 rems per minute at the x-ray tube (NIH, 1972). Follow the specific procedures for training, operation and emergency response that have been developed for these devices.
12. Some machines such as analytical x-ray devices, irradiators and accelerators have individual safety programs. These detailed operating and emergency procedures must be posted and followed.
13. Proper maintenance on all radiation producing equipment is essential. Only properly trained technical staff should perform all repairs to these instruments. Service personnel must be licensed or registered by the North Carolina Radiation Protection Section.

Radiation Safety Rules

It is the responsibility of those working with radioactive materials to protect themselves and others from radioactive hazards arising from their work. Poor examples and careless working habits can unnecessarily expose others or contaminate facilities. The following safety rules shall be posted in every radiation use area and shall be observed at all times:

1. EATING, DRINKING, SMOKING, AND THE APPLICATION OF COSMETICS ARE PROHIBITED EXCEPT IN AREAS THAT HAVE BEEN SPECIFICALLY DESIGNATED AND POSTED AS FOOD ITEMS AREAS.
2. WORKING WITH RADIOACTIVE MATERIALS WHEN OPEN WOUNDS ARE PRESENT ON EXPOSED SURFACES OF THE BODY IS PROHIBITED UNLESS WOUNDS ARE PROPERLY DRESSED AND PROTECTED.
3. PIPETTING OR ANY SIMILAR OPERATION BY MOUTH SUCTION IS PROHIBITED.
4. PROTECTIVE GLOVES SHALL BE WORN WHEN HANDLING CONTAMINATED OR POTENTIALLY CONTAMINATED ITEMS.
5. DISPOSABLE ABSORBENT PADS AND REMOTE HANDLING DEVICES SHALL BE UTILIZED WHEN POSSIBLE.
6. HANDS SHOULD BE WASHED THOROUGHLY AFTER HANDLING RADIOACTIVE MATERIALS, ESPECIALLY BEFORE EATING.
7. FOOD ITEMS SHALL NOT BE STORED IN AREAS DESIGNATED FOR RADIOACTIVE MATERIALS OR CHEMICALS.
8. PERSONNEL MONITORING BADGES SHALL BE WORN IN CONTROLLED AREAS, AS APPLICABLE.
9. RADIOACTIVE WASTE SHALL BE DISPOSED OF ONLY IN THE CONTAINERS PROVIDED. NONSTANDARD CONTAINERS ARE PROHIBITED.
10. STOCK SHIPMENTS SHALL BE HANDLED AND STORED IN SPECIALLY DESIGNATED LOCATIONS.
11. GOOD HOUSEKEEPING SHALL BE MAINTAINED AT ALL TIMES.
12. SPILLAGE SHOULD BE PREVENTABLE, BUT IN THE EVENT OF SUCH AN ACCIDENT, FOLLOW THE ESTABLISHED EMERGENCY PROCEDURES.
13. CONDUCT RADIATION METER AND WIPE TEST SURVEYS FREQUENTLY. WHEN MEASUREMENTS ARE ABNORMAL, FIND THE CAUSE AND CORRECT.

CHAPTER FOUR

ACQUISITION OF RADIATION SOURCES

Purchasing Radioactive Materials

When ordering radioactive materials, purchase requisitions are to be sent directly to EHS, 1120 Estes Drive Extension, CB# 1650, for approval and forwarding to the Purchasing Department. In most instances, requisitions are forwarded within two hours after receipt by EHS. Failure to forward requisitions directly to EHS will result in their return without processing.

From University Business Manual, Policy Statement 47

- EHS Review

EHS reviews the requisition to determine the following:

1. The Authorized User has been authorized to use the type and quantity of radioactive material being ordered. The name of the Authorized User must be clearly indicated on the requisition;
2. The radioactive material being ordered will not cause the Authorized User's inventory limits to be exceeded, and that the form, "Certification of Current Inventory for Purchase of Radiation Sources (<http://ehs.unc.edu/ehs/forms.shtml#rad>) accompanies the requisition;
3. The Authorized User has no unresolved items of safety noncompliance, including responses to survey reports, survey instrument calibration failures and training notices;
4. The Authorized User's Radionuclide Inventory Reports are current;
5. The requisition states the order is to be delivered to EHS.

When the above criteria are met, the requisition is approved and forwarded to the Purchasing Department. If the above criteria are not met, the Authorized User is notified by telephone to expedite acquisition of the necessary information. Refer to the following "Procedures for Placing Orders for Radioactive Materials": <http://ehs.unc.edu/radiation/general.shtml#orders>.

- Receipt and Delivery of Orders:

EHS is open for receipt of radioactive materials shipments 8:00 A.M. – 5:00 P.M. Monday-Friday, University holidays excepted. Upon receipt of a shipment, the package is checked for removable contamination, (as required by Department of Transportation Regulations) added to the Authorized User's inventory record and delivered to the Authorized User's lab, on the same day if it is received at EHS by 1:00 P.M. Shipments received after this time will be delivered on the afternoon of the following business day. If a representative for the lab is not available to receive and sign for the shipment or if the Appendix C is unavailable, the package will be held by EHS at the owner's responsibility.

Purchase of Radiation-Producing Equipment*:

Various types of equipment produce radiation by design or incidental to the primary purpose of the device. Design and performance standards have been imposed on manufacturers through the “Radiation Control for Health and Safety Act of 1968” administered by the Center for Devices and Radiological Health, FDA, U.S. Department of Health and Human Services. The purpose of the Act is to protect the public from unnecessary exposure to radiation from “electronic product radiation.” The Act applies to products that emit x-rays, ultraviolet, infrared or microwave radiation, lasers, ultrasonic equipment and other electronic devices.

Because the degree of hazard is dependent on the method or location of installation and in some cases may change with age of the equipment, EHS is responsible for reviewing Purchase Requisitions and utilization of radiation-producing equipment to insure proper installation and periodic surveillance. Purchase Requisitions for radiation-producing equipment are to be sent directly to EHS. EHS will review the Purchase Requisition, noting the location where the equipment is to be installed, and determine if shielding or other special requirements will be necessary. To expedite the review, a brief description of how the equipment will be used and any special safety precautions or operation procedures should be included.

*From University Business Manual, PUR Policy Statement 46.

Requirements for special forms of radiation sources:

- Sealed Sources

Sealed, or encapsulated, sources of radioactive materials may be listed by specific reference in the University’s Radioactive Materials License, which means that the license must be amended for each additional source. Application for authorization to obtain and use a sealed source must be made using the procedure in Chapter 2 of this manual. The application will be reviewed by the Radiation Safety Office and transmitted to the Radiation Safety Committee for its approval. After approval, the source(s) are purchased as any other radioactive material.

- Gas Chromatograph Sources

Gas chromatographs using Tritium or Nickel-63 foils in electron capture detectors must be equipped with a temperature limiting device and vented to a hood or air handling system which exhausts directly to the outside. Tritium foils are to be limited to 225 degrees Celsius and Nickel-63 foils to 400 degrees Celsius. Nickel-63 sources will be leak-tested semi-annually by the Radiation Safety Officer. The source holder must be labeled with the radiation symbol. Chromatograph sources must be disposed of through EHS as radioactive waste. Any change in location or status of a gas chromatograph must be reported to EHS.

- Leak Tests of Sealed Sources and Gas Chromatograph Sources for Contamination

Most sealed sources and gas chromatograph sources are required to be leak tested for containment integrity at six-month intervals. The Radiation Safety Office will perform this test. A report of the results will be provided to the Authorized User.

- Action Level

Any source having removable contamination greater than 5 nanocuries will be removed from service.

- Inventory of Devices, Gas Chromatographs and Liquid Scintillation Counters

EHS will inventory instruments emitting radiation or containing sealed sources or foils, such as liquid scintillation counters and gas chromatographs, at six-month intervals. Each instrument is also conspicuously posted with an identification sticker designating the radiation source information. EHS must be notified if the location or status of this type of instrument changes. EHS will remove the radiation source in these instruments prior to transferring them to Surplus Property. Notify EHS prior to any changes in location, surplus, or transfer of these instruments.

CHAPTER FIVE

RADIATION SOURCE INVENTORY

Records-keeping Requirements:

The University is required to maintain accurate, timely records of the receipt, use, transfer and disposal of radiation sources in its possession. Authorized Users have this same responsibility for their sources. These records must be maintained by the Authorized User for at least three (3) years and be readily available for periodic review by EHS and/or regulatory personnel.

- Inventory Control Numbers:

The Inventory Control Number is an eight-digit number assigned to each radioactive item/vial logged in through EHS. This number is physically attached to each radioactive source vial. The first four digits, to begin with 0001 each year, will run serially in the sequence in which shipments are logged in during the year. The second four digits are to indicate the month and year the item is processed, e.g., the second four digits of shipments logged-in during September 1999 would be "0999". The Inventory Control Number provides a unique means for identifying each item in a shipment. The Inventory Control Number must remain attached to the source vial until all the material is used or disposed of. Aliquots removed from a source vial must also be labeled with the related Inventory Control Number.

- Authorized User's Radioactive Materials Inventory Record Form:

A copy of the Authorized User's Radioactive Materials Inventory Record Form, Appendix D, (<http://ehs.unc.edu/ehs/forms.shtml#rad>) will be provided with each vial of radioactive material delivered to an Authorized User by EHS. An Inventory Control Number will be listed on the Appendix D and will be used to identify each item on the Monthly Radioactive Materials Inventory report described below. Appendix D is provided to record all transfers of the specific radionuclide. These forms must be readily available for review by EHS personnel.

- Monthly Radioactive Materials Inventory Report:

A Monthly Radioactive Materials Inventory report is required by EHS each month so that the total activities of all licensed radionuclides for the University can be compiled as required by the terms of the University's Radioactive Materials License. The first week of each month, EHS sends an email reminder to all Authorized Users to log into the Online Radioactive Materials Inventory (<https://itsapps.unc.edu/RadiationInventory/>) to update their monthly inventory. The Authorized User is to update the inventory by filling in the quantity of radionuclides transferred (to or from other persons) during the previous month, the quantity disposed of to the sewer, the quantity of waste transferred to EHS, and the quantity of radioactive materials on hand at the end of the inventory report period. Upon completion of the inventory update, the Authorized User will print out the report and place in his radiation safety records. EHS will reconcile all Authorized User inventories. The inventory update must be completed, printed, and filed by the lab by the 15th of the month. Requisitions for radioactive materials will be held and not processed if the inventory is not kept up-to-date and reported by the prescribed time.

CHAPTER SIX

RADIATION AND CONTAMINATION SURVEYS

Responsibility

Prevention of the spread of contamination and excessive radiation exposure is the responsibility of the Authorized User. The Authorized User is also responsible for providing radiation detection equipment to monitor removable contamination and external radiation exposure levels as appropriate. Radiation detection devices, such as liquid scintillation counters, gamma counters, and portable survey instruments, must be available.

- Laboratory Surveys:

"Survey" means an evaluation of the radiation hazards incident to the use, release, disposal and presence of radioactive materials and other sources under a specific Authorized User. A survey should include measurements of external radiation levels near sources in use, storage, waste containers, etc. and of removable contamination by wipe testing (refer to Contamination Survey Procedure at <http://ehs.unc.edu/forms.shtml#Radiation%20Safety%20Forms> . Both restricted (areas posted with radiation warning signs and labels) and adjacent unrestricted areas should be included. Surveys should also include an examination of the presence and condition of warning signs, instructions and other necessary postings and a thorough review of the records-keeping system.

During the monthly survey, records-keeping systems and the Radiation Safety Notebook should be reviewed for completeness and orderliness. Waste storage, records and security should be examined also during the monthly survey.

- EHS Surveys:

EHS personnel periodically inspect the laboratories of Authorized Users to monitor the in-lab radiation safety program. Radiation exposure rates and removable contamination levels are measured and records-keeping systems are reviewed during the surveys. The frequency of surveys is determined by the quantity of radioactive materials used, results of previous surveys, and general compliance with State and University safety and health regulations and policies. Although the EHS inspections fulfill a need for supervisory overview, they do not provide adequate day-to-day information regarding the effectiveness of radiation control procedures used in the laboratory. Therefore, laboratory personnel must routinely monitor their laboratories when using radiation sources.

- Authorized User Surveys:

Each Authorized User is required to conduct formal, documented surveys on a regular basis in every authorized radiation use space. The Radiation Safety Office establishes this survey schedule during application review. The typical schedule *requires the survey to be performed within each* calendar month. The schedule is subject to change through the Radiation Safety Office in accordance with the frequency of source use, potential for exposure and the established safety record.

When higher energy beta emitters, such as P-32, or gamma emitters, such as I-125, Na-22, etc. are used in the laboratory, the monthly Authorized User survey must consist of a wipe test and instrument survey using a portable, handheld survey meter. The instrument make, model number, serial number, calibration date, and readings must be recorded on the written survey report. Instrument surveys are specified in the radiation source authorization, if required. When lower energy beta emitters; such as H-3, C-14, or S-35, or small quantities of gamma emitters contained in commercial test kits, are used in the laboratory, only *wipe test* surveys are required.

During the monthly Authorized User survey, records-keeping systems and the Radiation Safety Notebook should be evaluated for completeness and orderliness. Waste storage, records, security, and the overall laboratory radiation safety

program should also be reviewed. If no radioactive material has been used during a month, a statement of that fact may be entered into the Radiation Safety records in lieu of a recorded survey. *However, a* record of the survey performed after the last use must be on file, showing that all radiation and contamination levels are within the specified guideline limits. For Authorized Users having more than one room authorized on their radiation us license, a statement of "No Use" may be entered for the individual rooms where radioactive materials was neither used nor stored (including waste) for the month. As such, a survey is required only in those rooms where use or storage occurred during the calendar month. The Radiation Safety Office may, according to particular conditions including quantities or types of materials and an Authorized User's safety record, set radiation safety survey schedules specifically designed for named laboratories or Authorized Users.

- Instrument Surveys:

The routine use of radiation survey instruments during the course of any work utilizing gamma or higher energy beta emitters (other than H-3, C-14, S-35, etc.) is required. After each use of stock solutions:

Monitor hands, arms, front of lab coat and other potentially contaminated areas.

Monitor bench tops, floor areas, equipment, etc.

Monitor hands and clothing before leaving the laboratory.

Do not use a survey meter that has not been calibrated within the past year for any purpose. Never use a survey meter that indicates "low batteries". Any meter that is not operating properly or is out of calibration must be tagged or labeled as "Out-Of-Service". Low batteries should be replaced at once. If an instrument is put in storage, the batteries should be removed. Old or spent batteries are prone to leakage and can ruin an instrument.

- Wipe Tests:

Wipe tests are performed by wiping a filter paper disk, Q-tip, etc., across the areas of interest and then determining the activity in a counter calibrated for the suspected radionuclide. Wipe tests are more sensitive than instrument surveys and should especially be used when instrument surveys indicate possible contamination. They are the only practical method of monitoring weakly penetrating beta emitters, such as H-3, C-14, S-35 and are to be substituted for instrument surveys for such emitters. *The wipe test method must* be used for all surveys conducted for identifying and/or documenting removable contamination levels.

When radioactive contamination is found above the action levels, clean and decontaminate the area. Re-survey with wipe tests and record the results to document adequate cleanup.

- Action Levels:

External Radiation - Radiation levels must be kept to less than 2 mrem/hr at 30 cm (12 in) from the source surface and to levels as low as reasonably achievable.

Areas in which the radiation exposure level exceeds 5 mrem/hr must be designated as a "Radiation Area" and posted with an appropriate sign (available from EHS). When such levels are expected, the RSO will indicate specific procedures to be followed when the "authorization" to use radioactive materials is issued. When such conditions arise that are not covered by the authorization, the RSO must be contacted immediately.

Contamination - EHS records removable contamination levels in terms of disintegrations per minute (DPM) per 100 square centimeters (standard areas to be covered by a "wipe"). Wipe test survey results by Authorized Users must also be recorded in DPM. Counting efficiencies used to convert from CPM to DPM may be stated in the Authorized User's records in lieu of converting to DPM. Typical liquid scintillation counting efficiencies are 20 percent for H-3 and 50 percent for other radionuclides. Laboratories may use the same counting efficiencies for wipes or use their own established efficiencies. Actions to be taken as a function of contamination level are:

Contamination Level, DPM	Action
Below 600 DPM	Record actual measurement for formal survey. Cleanup recommended to as low as practicable levels. No safety variance
600 DPM and Above	Record actual measurement for formal survey. Cleanup to less than 600 DPM is <u>required</u> , and as far below as practicable is recommended. Record actual measurement after cleanup for formal survey. Citation for safety variance
Special Situations: Interiors of <u>posted</u> hoods, storage cabinets, refrigerators, sinks, etc.	
Below 2000 DPM	Record actual measurement for formal survey. Cleanup to as low as practicable levels. No safety variance.
2000 DPM and Above	Record actual measurement for formal survey. Cleanup to less than 2000 DPM is <u>required</u> , and as far below as practicable is recommended. Record actual measurement after cleanup for formal survey. Citation for safety variance
Special Situations: Interior of <u>dedicated, posted, sole user</u> microfuges, speedvacs and centrifuges:	
Below 15000 DPM	Record actual measurement for formal survey. Cleanup to as low as practicable levels. No safety variance.
15000 DPM and Above	Record actual measurement for formal survey. Cleanup to less than 15000 DPM is <u>required</u> , and as far below as practicable is recommended. Record actual measurement after cleanup for formal survey. Citation for safety variance

- Training:

The specifics of how to perform contamination and radiation surveys will be covered in the radiation safety training sessions which all laboratory personnel and new Authorized Users are required to attend prior to use with radioactive materials. During the first three months following authorization of a new User, EHS personnel will assist as requested in establishing routine surveys, which are required by conditions of the User's Authorization.

- Survey Instrument Calibration:

Survey instruments must be calibrated annually. The calibrations will be performed by the Radiation Safety Office, without charge. The Radiation Safety Office must be informed whenever a new instrument is purchased, after significant repair or other calibration has been done.

- Removal of Laboratory Equipment:

Any equipment in the laboratory which could have been contaminated with radioactive material must be surveyed before removal to another laboratory, transfer to a repair shop, or transfer to Surplus Property. Before the equipment is transferred and following a satisfactory survey, all warning signs and stickers must be removed. A Safety Clearance Form, Appendix F (<http://ehs.unc.edu/ehs/forms.shtml#rad>), must also be completed. This form should be provided to the appropriate personnel to designate that the equipment is considered safe for any use.

- Vacating Laboratory Spaces:

EHS must be informed of all changes in authorized laboratory spaces, including transfers or departures from the University and laboratory relocations. Written notification to EHS *is required* prior to vacating a lab or moving into different labs. The Authorized User is responsible for surveying all spaces and equipment and proper removal of all radioactive waste and radioactive sources prior to the changes. Upon notification, via the filing of a Safety Clearance Form, <http://ehs.unc.edu/ehs/forms.shtml#rad>, EHS will complete a final clearance survey of the authorized spaces.

CHAPTER SEVEN

EMERGENCIES

A radiation emergency may exist if unplanned exposure to radioactive material is possible due to loss, misplaced material or accident; or if same loss, misplaced material or accident may result in contamination of facilities or spread of contamination out of control. Since an emergency requires immediate action to reduce harm or damage, mCi quantities should be considered an emergency and uCi quantities should be considered an incident.

- **Emergency Procedure (mCi)**

Persons having knowledge of a possible radiation emergency should do the following:

1. Contain material as per lab emergency procedures
2. Keep uninvolved people out of area until cleanup or appropriate measures are completed.
3. Call EHS to:
 - a. Report the problem, stating whether emergency help is needed.
 - b. Arrange for assistance and/or final survey.
 - c. Record results of final survey to document adequate response.

- **Incident Procedure (uCi)**

Persons having knowledge of a radiation incident should do the following:

1. Contain the material to minimize contamination.
2. Keep uninvolved people out of area while cleaning up the spill, etc.
3. Report to the Radiation Safety Office as deemed appropriate.
4. Record results of final survey to document adequate response.

The Radiation Safety Office will:

1. Supervise cleanup or restriction of area until emergency no longer exists.
2. Determine that available personnel have cleaned area or have emergency in hand.
3. Determine if report must be made to regulatory agencies in case of loss of material or exposure of personnel, and make the necessary report.

Report all emergencies that threaten life or property to 911.

For other incidents requiring Radiation Safety assistance, call EHS at 962-5507 during normal working hours, or 911 after-hours.

CHAPTER EIGHT

PERSONNEL MONITORING

External Exposure

Personnel monitoring devices (whole body dosimeters, extremity dosimeters, pocket dosimeters, etc.) are provided by the EHS through the Radiation Safety Office to measure an individual's radiation exposure to gamma, energetic beta and x-ray sources. The standard monitoring device is issued as a clip-on badge or ring badge bearing the individual assignee's name, date of the monitoring period and a unique identification number. The dosimeters are provided, processed and reported through a commercial service company that meets current requirements of the National Institute of Standards and Technology National Voluntary Laboratory Accreditation Program (NVLAP).

- Requirements:

Radiation protection regulations and UNC-CH policy require that appropriate personnel monitoring equipment be provided to individuals who:

1. Are likely to receive a radiation dose in any calendar quarter in excess of 10 percent of:
 - a) 5 rems, total effective dose equivalent, to the whole body;
 - b) 15 rems, eye dose equivalent, to the lens of the eyes;
 - c) 50 rems, shallow dose equivalent, to the skin or to each of the extremities.
2. Are less than 18 years of age and are likely to receive a radiation dose in any calendar year in excess of 10 percent of:
 - a) 0.5 rems to the whole body;
 - b) 1.5 rems to the lens of the eyes;
 - c) 5 rems to the skin or to each of the extremities.
3. Have declared a pregnancy or planned pregnancy;
4. Enter a High or Very High Radiation Area (exposure to greater than 100 millirems in any one hour);
5. Operate analytical x-ray devices (both monthly ring and whole body badges required, at the discretion of the RSO);
6. Meet the issuance criteria as assessed by the Radiation Safety Office.

- Issuance Criteria:

Authorized Users must complete and submit the Lab / Radiation Worker Registration Form (<http://ehs.unc.edu/ehs/forms.shtml#rad>), for each individual who may work with radiation sources. This form provides for the basic information regarding training and experience and personnel monitoring needs. Initial personnel monitoring decisions will be based on this information. Further evaluations, and re-evaluations, will be made through radiation employee registration updates, application reviews, personnel monitoring reports, high dose investigations, surveys and individual interviews by responsible Radiation Safety staff members.

In general, personnel monitoring devices will be exchanged on the appropriate frequency for individuals needing personnel monitoring as specified in the REQUIREMENTS section above.

Personnel monitoring devices may be exchanged quarterly when less frequent and/or smaller exposures are anticipated. Experience has shown, for example, that quarterly exchanges are appropriate for operators of dental x-ray machines, many sealed sources and most laboratory radiation workers.

Personnel monitoring devices will not normally be issued to individuals who work solely with low energy beta emitters such as H-3, C-14 and S-35 or very small quantities of radioactive material such as I-125 in-vitro kits.

- Monitoring Protocol:

1. Radiation restricted area under such conditions that an occupational radiation dose in excess of 10 percent of the specified calendar year limits may occur. EHS will request prior radiation dose histories from all past employers.
2. Dosimeters will be exchanged on a monthly or quarterly basis depending on the anticipated exposure level as evaluated by the EHS .
3. All personnel occupational radiation dose records shall be maintained by EHS.
4. It shall be the responsibility of each individual dosimeter recipient to wear and use the dosimeter (s) properly.
5. Authorized Users are responsible for assuring their radiation workers are wearing badges appropriately and that badges are returned on time for reading.

NOTE: Departments may be charged for late or lost dosimeter.

- Other Personnel Monitoring Devices:

The Radiation Safety Office may require the use of pocket dosimeters, ring dosimeter, or other monitoring devices when particular procedures are in operation.

- Recording Exposures:

Measured personnel occupational radiation doses, including bioassay results, are to be recorded and maintained on file by EHS.

- Use of Personnel Monitoring Devices

The whole body dosimeter (or other device) is to be worn on the body where it will most likely approximate the radiation exposure to the head and torso of the wearer. A dosimeter assigned for whole body monitoring is not to be used to monitor the extremities (hands, forearms, feet, ankles). Separate badges must be assigned for extremity monitoring.

Generally, whole body dosimeters are to be worn between the waist and the neck. When a protective apron is worn, the badge is to be worn at the collar, outside the apron. In some circumstances, where exposure of the neck and lenses of the eyes is negligible, the monitoring badge may appropriately be worn under the apron. The Radiation Safety Office should be consulted for advice in these circumstances.

Extremity monitoring dosimeters (rings) are available in large or small size and for the right or left hand. Ring dosimeters should be worn whenever working with applicable sources. When using radioactive materials, the ring monitor element (label area) should be turned toward the palm. Gloves should be worn over the ring badge when contamination is possible.

The exposure of a personnel monitoring device to deceptively indicate a dose delivered to an individual is prohibited by North Carolina regulations.

- Personnel Monitoring Reports:

Occupational radiation dose reports are sent to each radiation employee group representative. The report(s) must be posted or otherwise provided such that each group member may learn of his/her own dose record. Routine monitoring periods are currently monthly or quarterly. Each report will include the name, monitoring period date, dose (millirems) for the immediate past period, current calendar quarter, calendar year and the lifetime dose for each member of the group.

- UNC Pregnant Employee - Fetal Dose Policy

The UNC-CH fetal dose policy incorporates safety information and radiation dose guidelines for ensuring safe radiation limits for the conceptus of occupationally exposed employees. A copy of the complete policy, declaration form and information booklet is available through any Authorized User. The information must be maintained in the laboratory Radiation Safety records and be readily available to any interested individual. For occupationally exposed employees not working for specific Authorized Users, the policy and supporting information is available upon request from EHS. Any person is welcome to discuss the policy or obtain a copy, by contacting the EHS, Radiation Safety Office, 1120 Estes Drive Extension, CB#1650, 962-5507.

Internal Exposure

- Bioassay Personnel Monitoring:

Bioassay is the determination of the kind, quantity or concentration, and location of radioactive material in the human body by direct (in vivo) measurement or by analysis (in vitro) of materials excreted from the body. Commonly employed bioassay techniques include urinalysis and thyroid monitoring. A bioassay program provides the necessary personnel monitoring to measure operational or accidental uptakes by radiation workers.

Radioactive material usage is approved only when the associated safety program, equipment, facilities and staff experience assures that safe use will be routinely maintained. The potential for radiation exposure due to inadvertent failures of procedures and equipment may increase, however, when certain combinations of radionuclides, chemical or physical forms and activities are involved.

Current health physics practices and safety survey results provide evidence that few, if any, radioactive material procedures currently in use allow routes for personnel uptakes. Some procedures do incorporate radionuclide form and activity combinations which warrant bioassay monitoring to assure that designated precautions remain effective.

A determination of bioassay personnel monitoring needs and frequency is made by the Radiation Safety Office during the review of applications. The status of existing usage programs is periodically reviewed through radiation worker registrations, surveys, inventory records and a semiannual or annual verification of radiation staff and radionuclide use limits.

Routine bioassay monitoring will be conducted when any individual is working with radionuclide form/activity combinations exceeding established limits. "Working with" includes withdrawing an aliquot from a stock supply which itself exceeds a limit, although the activity actually used is below the bioassay limit.

- Bioassay Radionuclide, Form and Activity Limits:

Tritium (H-3)

Urinalysis is required within 24 hours, if possible, but not later than 72 hours after working with 100 millicuries or more of tritium in any form.

Iodine (I-125, I-131)

An external thyroid bioassay by external counting is required within 24 hours, if possible, but not later than 72 hours after working with the following limits or greater:

1. Processes in open room or bench with possible escape of iodine from process 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
3. Processes carried out within gloveboxes, ordinarily closed, but with possible release of iodine from process and occasional exposure to contaminated box and box leakage:
 - 100 mCi if volatile form
 - 1000 mCi if bound to nonvolatile agent

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

Urinalysis is required within 24 hours, if possible, but not later than 72 hours following potential ingestion, inhalation, or skin contamination of personnel. Additional urinalysis or external organ counting may be conducted, depending on the biological attributes of a specific radionuclide.

- Analysis and Record-keeping:

Any employee's request for a bioassay analysis will be honored. Pregnant radiation workers using radioactive materials will be placed on a mandatory monthly bioassay schedule.

Standard methods for bioassay evaluations are normally sufficient to measure body or organ uptakes of radionuclides to a small fraction of an Annual Limit on Intake (ALI) . An outside laboratory specializing in bioassay services will be used for any analysis requiring extraordinary equipment or procedures. Internal dose results will be recorded, added to any external occupational dose, and maintained as part of the radiation worker's overall personnel monitoring history.

- Investigation Levels:

External Exposure

Specific procedures for responding to any occupational radiation dose, which exceeds Level I or Level II in the following table, have been established.

Part of Body	Investigation Level I (millirems per monitoring period)	Investigation Level II (millirems per monitoring period)
Whole body, head trunk, gonads or lens of the eyes	100	400
Extremities: arm, elbow, forearm, hand thigh, knee, leg, foot	1000	3000
Skin	1000	3000
Conceptus	30	40

Action Procedures:

When Level I doses are exceeded, the RSO shall send a written description of the dose report statistics, including the dose history for the previous two monitoring periods, to the person involved with a copy to the Authorized User. The individual will be requested to review his or her radiation safety procedures and work habits in an effort to maintain all doses as low as reasonably achievable. Radiation safety reviews and consultation are offered.

When Level II doses are exceeded, the RSO shall conduct a direct investigation of the situation, including an interview with the person involved. A written investigation report shall be made, including dose trends over the past one year (as available) for that person. The person involved is provided with a copy of the report for review and signature. Conclusions drawn from the investigation provide a basis for confirming or modifying the dose and for establishing corrective actions to be taken.

If a regulatory overexposure occurs, the required reports will be filed with the North Carolina Radiation Protection Section.

- Investigation Levels:

Internal Exposure

Part of Body	Investigation Level I	Investigation Level II
	(millirem per monitoring period)	(millirem per monitoring period)
Whole body*	100	400
Individual organ**	1000	3000

* Committed Effective Dose Equivalent (CEDE)

** Effective Dose Equivalent

Action Procedures:

When a Level I dose is exceeded, the RSO will send a written description of the dose report, including the occupational dose history for the previous two monitoring periods, as available, to the person involved and to the Authorized User. The individual will be requested to review his or her radiation safety procedures and work habits in an effort to maintain all doses as low as reasonably achievable. Radiation safety reviews and consultations will be considered.

When a Level II dose is exceeded, the RSO will conduct a direct investigation of the situation, including an interview with the person involved. A written investigation report will be made, including total dose trends over the past 12 months (as available) for that person. The person involved will be provided with a copy of the report for review and signature. Conclusions drawn from the investigation will be used as a basis for confirming or modifying the dose value and for establishing any corrective actions to be taken.

Any confirmed internal dose of 10 millirems or more will be recorded in the involved individual's permanent occupational radiation personnel dose record. When the individual is also being monitored for external occupational radiation dose, the internal dose and external Deep Dose Equivalent will be summed and recorded on the permanent external dose record as the Total Effective Dose Equivalent.

Whenever any regulatory radiation overexposure occurs, the required reports will be filed with the North Carolina Radiation Protection Section by the RSO.

CHAPTER NINE

DISPOSAL OF RADIOACTIVE WASTES

Key terms are identified in bold type and are defined at the end of this Chapter.

It is important to dispose of **radioactive wastes** in accordance with radiation protection regulations. This avoids exposure to personnel and contamination of the environment. It also avoids regulatory penalties and the possible loss of radioactive material use privileges. Radioactive wastes are not permitted to be disposed in the sanitary landfill and must not be placed in any container used for the collection of non-radioactive waste, no matter how temporary the use is intended.

Key terms are identified by bold type and defined at the end of the Chapter.

Disposal to the Sewer

Only trace quantities of radioactive material associated with glassware cleaning may be discarded to the sewer. Specific authorization from the Radiation Safety Office is required for any exceptions. All authorized releases must occur in a designated, posted drain. Records of each release, including radionuclide, quantity, chemical and/or physical form, date, and time must be documented and maintained.

Segregation and Packaging Radioactive Waste for Pickup

EHS provides all radioactive waste **containers** and removes all **radioactive wastes** from laboratories. Each container requires the completion of a Radioactive Waste Disposal Record obtained through the radioactive waste disposal web application (https://itsapps.unc.edu/HazMat_Pickup/). Request for delivery of empty containers and are also available from this web application. Three standard container types are available and used; specially marked cardboard boxes for dry waste, 4 liter glass bottles for **liquid waste**, and 5, 15, or 30-gallon drums for scintillation vials. Specific authorization from the Radiation Safety Office is required for any exceptions.

All waste must be **segregated** by half-life category:

- a. Short-lived, half-life ≤ 165 days;
- b. Long-lived, half-life ≥ 165 days.

There are seven types of **radioactive waste**:

1. Biological Materials *and animal carcasses*,
2. Dry Solids,
3. Liquids,
4. Scintillation Vials,
5. Source Vials,
6. Mixed Wastes, and
7. Pigs, *shielding*.

The following packaging requirements must be met for waste removal.

1. **Biological Waste**

- a. Segregate wastes according to half-life category:
Short-lived, half-life ≤ 165 days,
Long-lived, half-life ≥ 165 days.

H-3, C-14, and I-125 in concentrations less than 0.05 uCi/g.

- b. Place waste in a clear plastic bag in a freezer.
- c. Each bag must be labeled with a radioactive materials sticker, listing the Authorized User's name, radionuclide, activity and date.
- d. The serial number from the Radioactive Waste Disposal Record must be written directly on the plastic bag, using a "permanent" marker.

2. Dry Waste

- a. Segregate wastes according to half-life category.
- b. No free liquids, lead shielding, scintillation vials or organic solvent are allowed.
- c. **Sharps must be placed in a hard-walled plastic or cardboard container before being placed in the dry waste box.**
- d. Infectious dry wastes must be sterilized by autoclaving before placement in radioactive waste containers. Autoclaving radioactive infectious waste must be specifically approved by the Radiation Safety Office.
- e. Source vials containing short-lived radionuclides may be placed in the short-lived dry waste box after first removing any lead shielding material. Do not place source vials in the dry waste box if they create unacceptable radiation levels (> 2 mrem/hour at 1 foot from a box).
- f. Empty source vials for long-lived radionuclides may be placed in the long-lived dry waste. Residual liquids, up to a few milliliters, may be absorbed on a pad or towel and added to the dry waste container. This procedure may be used only for source vials containing less than 10 mCi.
- g. Minimize the amount of glass and metal by washing these materials and disposing as ordinary trash.
- h. To prepare the box delivered by the EHS Hazardous Materials Technician :
 - 1. Turn the folded box upside down.
 - 2. Fold the bottom flaps with opposing sides in (do not weave).
 - 3. Secure bottom flaps with reinforced packaging tape.
 - 4. Turn the box to the upright position.
 - 5. Place the yellow plastic bag provided by the EHS Hazardous Materials Technician in the box and fold the bag opening over the lip of the box.
- i. Prior to requesting pickup by the EHS Hazardous Materials Technician, the box must be close by sealing the bag with tape and taping the lid in place. Tape the Radioactive Waste Disposal Record to the top of the box

3. Liquid Waste

- a. The bottle is delivered with a blank yellow tag attached.

This tag must contain the following before waste is added:

Authorized User's name.
Radioactive Waste Disposal Record Serial Number.
Radionuclide(s),

When the bottle is full, the tag must also include:

Activity
Date when the activity is recorded.

- b. Segregate wastes according to half-life category.
- c. Do not mix biodegradable and non-biodegradable liquids.

- d. No solids, including filters, pipette tips, stir bars, gels and vials, are allowed.

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- e. Use only the four-liter bottles provided by EHS unless other arrangements have been made with the EHS Hazardous Materials Manager.
- f. Glass bottles must have secondary containment (rubber safety bucket or plastic container).
- g. Leave at least a 10% headspace.
- h. Chemical constituents, including water and scintillation media trade names, and their percentages must be listed on the Radioactive Waste Disposal Record.
- i. Remove external contamination prior to waste pickup.

4. Scintillation Vials

- a. Use only drums provided by EHS.
- b. Segregate by half-life category.
- c. Vials must be packed upright in flats or sealed clear plastic bags containing no more than 100 vials. Place these bags in a lined drum.
- d. Segregate vials according to the type of scintillation media:
 - Biodegradable or non-hazardous media that do not meet the criteria of a hazardous waste.
 - Non-biodegradable or ignitable which becomes a mixed waste during use.
- e. Chemical constituents or scintillation trade names must be listed on the Radioactive Waste Disposal Record.
- f. No dry vials, test tubes, dry wastes or non-scintillation fluids are allowed.
- g. Vials must have tight, secure tops to prevent leakage during storage and waste handling.

5. Source Vials

- a. **Source vials** containing short-lived radionuclides may be placed in the short-lived dry waste box . Do not place source vials in the dry waste if they create unacceptable radiation levels (>2 mrem/hr at 1 foot from the box).
- b. Empty source vials for long-lived radionuclides may be placed in the long-lived dry waste. Residual liquids, up to a few milliliters, may be absorbed on a pad or towel and added to the dry waste container.
 - This procedure may be used only for source vials containing less than 10 mCi. Otherwise, the residual contents must be emptied into the appropriate liquid waste container.
- c. Contact EHS for removal of:
 - Long-lived sources with activities greater than 10 mCi,
 - Short-lived sources which yield surveys of > 2 mrem/hour at 1 foot from a vial or source.

6. Mixed Wastes

Liquids and scintillation vials are subject to EPA regulation if they possess characteristics of hazardous waste. These characteristics include ignitability (flashpoint < 140° F) and corrosivity (pH < 2 or > 12.5). Failure to comply with the following rules may result in EPA fines of up to \$27,000 per day per occurrence.

- a. *All containers of mixed waste must be labeled or marked with the words "Hazardous Waste".*
- b. *All containers of mixed waste must remain closed at all times except when waste is being added or removed to the container.*

7. Pigs

Lead pigs or other lead-containing materials must not be placed in the radioactive waste containers. The lead will be picked up and recycled. These items must be wipe-tested for removable contamination prior to calling for a pickup. A copy of the survey results, in DPM, must be attached to a Radioactive Waste Disposal Record. Removable contamination must not exceed 600 DPM.

- **Radioactive Waste Disposal Records**

The terms of the University's Radioactive Materials License require detailed records of the receipt, use and disposal of radioactive materials. To facilitate maintenance of disposal records, a **Radioactive Waste Disposal Record**, is provided through the radioactive waste disposal web application for use by Authorized Users. This form is to accompany each container (box, drum, bottle, etc.) of radioactive waste.

The computer generated form includes a "Serial Number" in the center top of the form. If space for additional disposal entries is required, generate another form with the same serial number from the web application. Boxes and drums must have this serial number marked on the outside of the **container**. **Liquid waste** containers must have this serial number marked on the yellow tag.

Radionuclides and activities of all waste in each **container** must be specified on the Form 102. Total activities, in curies or millicuries, are to be specified prior to waste pickup. Chemical constituents and their percentages must be specified for liquids and scintillation vials prior to pickup.

The Form 102 is to be signed by the Authorized User, or designee, as certification of the **container** contents. When the waste is picked up, the EHS Hazardous Materials Technician will sign the form to acknowledge transfer of the waste, and leave a copy for the Authorized User's records.

- **Radioactive Waste Pickup**

Log onto the **radioactive waste disposal** web application at (https://itsapps.unc.edu/HazMat_Pickup/) for waste form generation, request for pick-up, and request for containers. You will be prompted for the following information:

- Authorized User's name,
- Building name and room number,
- Phone number,
- Type of waste (biological, dry, liquid, scintillation vials, source vials, pigs),
- Serial numbers (from previously generated forms) for each waste container to be picked up, and
- The number and type of replacement containers needed.

Submissions for waste pickup and container delivery made by noon on a Friday are scheduled for pickup/delivery the following week.

- **Radioactive Waste Readiness Checklist**

Before requesting a pickup of waste, check to ensure that the following has been done:

1. **Dry Waste**
 - a. Liner sealed,
 - b. Lid taped on box, and
 - c. **Radioactive Waste Disposal Record** is completed.
2. **Biological Waste**
 - a. Sealed in clear plastic bag,
 - b. Frozen,
 - c. Labeled with permanent marker,
 - d. List weight of waste,
 - e. List activity / weight in uCi/g, and
 - f. **Radioactive Waste Disposal Record** is completed.

3. Scintillation Vials

- a. Liner sealed,
- b. Lid placed on drum,
- c. List name of media or chemical constituents, and
- d. **Radioactive Waste Disposal Record** is completed.

4. Liquids

- a. Lid in place,
- b. 10% head space, and
- c. **Radioactive Waste Disposal Record** and yellow tag is completed.

- **Laboratory Radioactive Waste Procedures**

The Radiation Source Security Procedure, Appendix I, at (<http://ehs.unc.edu/ehs/forms.shtml#rad>) describes the responsibility of the Authorized User for the security of all radiation sources and **radioactive** waste until it is picked up by EHS for disposal. Only standard **radioactive waste containers**, provided or approved by EHS, are allowed. The housekeeping supervisor information must be completed in the space provided on the procedure, and it must be conspicuously posted at each **radioactive waste container or waste storage** area.

- **Shared Space for Storage of Radioactive Waste**

Two or more Authorized Users may enter an agreement and be approved for a single, shared **radioactive waste** storage space. A shared space approval offers significant space-saving advantages. It also requires excellent mutual responsibility and cooperation between the Authorized Users and their staffs. Each member of the agreement must work to assure that the group consistently meets all the associated safety requirements. These requirements include:

1. Each person must be an Authorized User and be individually approved for the room.
2. The room must be posted and secured by lock. Access control must be sufficient to preclude entry by unauthorized persons. The room must be locked when unattended.
3. Each Authorized User is responsible for conducting monthly radiation safety surveys of the room. A single individual may do the survey or each Authorized User may conduct their own. In any case, a copy of each monthly survey must be maintained by each Authorized User.
4. Multiple Authorized Users may share **radiation waste** collection **containers**, if they individually maintain the required **Disposal Record** sheet and record the identity of the appropriate Authorized User with each record entry.
5. Good radiation safety practices shall be maintained.
6. Good housekeeping practices shall be maintained.

Room authorization will be terminated for individual Authorized Users who do not meet these requirements. The room authorization will be terminated for all Authorized Users if these requirements are not met and no responsible individual can be identified.

- **Definitions:**

Biodegradable - Refers to scintillation cocktails, which contain no hazardous chemical constituents.

Biological Waste - Animal carcasses and bedding material contaminated with radioactive material.

Container - Refers to a box, bottle or drum in which radioactive waste is collected and transported.

Dry Waste - Radioactive waste that does not contain free liquids. Dry waste may be damp from aqueous materials, but must not contain organic solvents or other material regulated as a hazardous waste.

Liquid Waste - Radioactive waste material to be disposed of that does not contain solids.

Mixed Waste - A radioactive waste that also exhibits the characteristic of a hazardous waste. Examples include chloroform, solvents with a flash point less than 140° F and corrosive liquids with a pH <2 or >12.5.

Nonbiodegradable - Refers to scintillation cocktails that contain hazardous chemical constituents (solvents).

Non Water Miscible Liquid - A liquid that is not miscible in water, e.g., chloroform, xylene, benzene, toluene, etc.

Pigs - A shielded container used in the transport and storage of source vials. Pigs are constructed of lead, plastic, or a combination of the two.

Radioactive Waste - Material to be disposed of that contains, or may contain, radioactive material.

Radioactive Waste Disposal Record - Also called the Form 102 (Appendix A). This is a record of all waste collected in a container. It is to be completed by the laboratory generating the waste. It also serves as a DOT shipping document for the container.

Scintillation Media - A liquid preparation to which a radioactive specimen is added for assay in a liquid scintillation counter. There are two categories of scintillation media waste: biodegradable and nonbiodegradable.

Sealed Source - A capsule containing radioactive material designed to be used without opening. Federal and State regulations prohibit opening sealed sources.

Source Vial - A vial in which stock radioactive material is delivered.

Water Miscible Liquid - A liquid or mixture of liquids that is miscible in water, e.g., water, mineral acids, acetic acid, ethanol, methanol, acetone, phenol, etc.

CHAPTER TEN

RECORDS

Under the terms of the University's authorizations to use radiation sources, EHS is charged with maintaining portal-to-portal surveillance of all radiation sources on the campus. In order to facilitate this surveillance and to insure that a high awareness of the rules and regulations governing the safe use of radiation sources is maintained, it is required that certain records and reference materials be maintained. These records and reference materials are the responsibility of the Authorized User, who is required to keep the material current and to make it readily available to laboratory workers, EHS, and the North Carolina Radiation Protection Section. It is recommended that a notebook be maintained with the required information. Records are to be maintained by the Authorized User for a period of three years unless advised otherwise.

These records and references include, but are not limited to, the following:

1. The University's current Radiation Safety Manual (<http://ehs.unc.edu/ehs/forms.shtml#rad>). All other versions must be discarded
2. Copies of the Authorized User's License and Application to Use Radiation Sources). *All license amendments must be maintained.*
3. Radioactive Materials Inventory Record forms (also called Daily Inventory form)
4. Monthly Radioactive Material Inventory Records (as generated by the Online Radioactive Material Inventory)
5. Radiation and contamination surveys performed by the Authorized User and EHS
6. Radioactive Waste Disposal records
7. Lab / Radiation Worker Registration forms
8. UNC-CH Conceptus Dose Policy

CHAPTER ELEVEN

SHIPPING RADIOACTIVE MATERIALS FROM UNC-CH

- **General**

Any shipment of radioactive materials from the University must be in full compliance with U.S. Department of Transportation, U.S. Nuclear Regulatory Commission and/or North Carolina requirements. These regulations are constantly changing. EHS maintains current copies, and the staff is trained and knowledgeable in their applications. Any person planning to ship radioactive material should contact the Radiation Safety Office for shipping and packaging requirements prior to any packaging of radioactive material for shipment to insure compliance with the regulations. All shipments of radioactive material from the University are to be inspected by “Hazmat trained” personnel from EHS prior to shipment.

- **Requirements**

1. Shipments may be made only to persons who are licensed to receive radioactive materials and in accordance with procedures established by such persons.
2. Prior to making a shipment of radioactive materials, a copy of the recipient's license must be on file in EHS.
3. Shipments must be arranged to be in accordance with the recipient's procedures for receiving radioactive materials.
4. All aspects of the shipment (container, packaging, labeling, surveys, shipping papers, etc.) must be in accordance with U.S. Department of Transportation requirements.
5. Radiation Safety shall make final inspection, survey and approval of all outgoing radioactive shipments. Please contact Radiation Safety in advance of any shipment so appropriate arrangements can be made.

- **Shipping Assistance**

Please contact EHS, 962-5507, at least 24 hours prior to shipment to insure adequate time for inspection and paperwork preparation.

CHAPTER TWELVE

PROTECTION OF VACUUM SYSTEMS

Experimental procedures involving radioactive and/or bio-hazardous materials frequently require the use of building vacuum systems or vacuum pumps. Such procedures can result in the accidental contamination of the vacuum system or laboratory pump with hazardous aerosols or fluids. The vacuum system or laboratory pump must be protected with a secondary reservoir and disposable filter assembly when this possibility for contamination exists.

The secondary reservoir consists of a side arm flask with plastic tubing running from the experiment to the lower arm of the flask. A second tube is connected to the upper arm of the flask and to the inlet port of the disposable filter assembly. The outlet port of the filter is connected to the vacuum source with a third tube. Ideally, the flask should be placed higher than the experiment so that liquid accidentally aspirated into the flask can drain back to the primary reservoir when the connection at the vacuum line is broken. The filters should have a rated capacity to remove particles .45 um or larger.

Filters potentially contaminated with biohazards shall be autoclaved before disposal. Filters contaminated with radioactive material shall be disposed of with other radioactive waste.

The disposable filter assembly can be purchased from Fisher Scientific (www.fisher.sci.com), part number 09-744-75 or 09-744-76, or available equivalent.

FUME HOOD SAFETY

Fume hoods must be individually authorized by Radiation Safety and posted with a radiation warning sign before using radioactive materials in them. Each approved hood must have a minimum airflow face velocity of 100 linear feet per minute. All radioactive materials use hoods are inspected annually by EHS's *Collaborative Laboratory Inspection Program (CLIP)* for adequate face velocity. Any hood that may not be in proper working order or having an inadequate face velocity should not be used. Promptly report any problems to the EHS.

CHAPTER THIRTEEN

ANIMAL HANDLING PROCEDURES

Projects involving administration of radionuclides to animals require information on specific arrangements for housing the animals during the project. Information required includes:

1. The kind and number of animals to be used in the study (# per experiment + total # of experiments).
2. The radionuclide to be administered per animal and how administered.
3. The ultimate fate of the animal and suspected excretion rate of the radionuclide.
4. Instructions for handling and monitoring of the animals and proposed method of disposal of the animal and excreta. These instructions shall be posted in the animal housing area.

If the total amount of administered nuclide per experiment exceeds the quantity found in the N.C. Regulations for Protection Against Radiation, Exempt Quantities Table, then the animals must be housed in areas designed for hazardous materials as assigned by the Director of Laboratory Animal Medicine (DLAM). Special handling instructions are to be forwarded to the animal care personnel and posted prior to administering the radionuclide to the animals.

If the total amount of administered nuclide per experiment is less than the quantity posted in the Exempt Quantities Table, then arrangements can be made to house the animals in any area approved by the Director of Laboratory Animal Medicine and the Radiation Safety Officer. Such low-level studies may be conducted in approved laboratories when the animal survival time does not exceed 12 hours. Longer survival times require Division of Laboratory Animal Medicine (DLAM) housing. A "Use of Radioactive Materials in Laboratory Animals" Form (<http://research.unc.edu/iacuc/forms.php>) must be submitted to and approved by the EHS before space can be assigned in the DLAM isolation facilities.

Specific Requirements:

1. Cages or isolation units are to be designated as radioactive use areas.
2. Bedding and excrement are to be collected as radioactive waste. Contact the Hazardous Waste Section in the EHS, for waste packaging information.
3. Cages are to be cleaned and surveyed at the end of each individual experiment. Survey records are to be maintained by the Authorized User.
4. The DLAM must be notified of the need for cages to be used in studies with radionuclides. Contact DLAM for assistance.

CHAPTER FOURTEEN

ANALYTICAL X-RAY MACHINES

Radiation Emergency Procedures

IF YOU ARE EXPOSED TO THE DIRECT X-RAY BEAM, OR SUSPECT AN EXPOSURE, IMMEDIATELY FOLLOW THESE STEPS:

1. Shut off the x-ray beam.
2. Remain calm. Call these contacts until (1) medical advice is obtained and (2) the incident is reported.

Medical Advice/Incident Reporting

James Larson, M.D., Director, Emergency Medicine. 966-5643
 EHS 962-5507
 M.A. Varia, M.D. 966-7700
 AFTER HOURS CONTACT, UNC Police. 911 (Ask for Radiation Safety Assistance)

Safety Procedures:

X-Ray diffraction and spectrographic devices generate in-beam radiation dose rates of 30 to 7000 rads/sec. Severe tissue damage can be inflicted by very brief exposures to these high dose rates. Surgical treatment or amputation may be required when small body parts, such as fingers, receive greater than 1000 rads.

It is imperative that stringent safety precautions be applied when using these devices. Safety precautions include mechanical and electrical guards as well as proper training and instruction. The following safety procedures have been established to help prevent accidents. Adherence to these rules is mandatory.

1. NO PERSON SHALL BE PERMITTED TO OPERATE ANALYTICAL X-RAY MACHINES UNTIL THEY HAVE:
 - a. Received instructions in relevant radiation hazards and safety.
 - b. Received instructions in the theory and proper use of the machine.
 - c. Demonstrated competence, under supervision, to safely use the machine.
2. RADIATION EXPOSURE TO THE OPERATOR AND OTHERS SHALL BE KEPT AS LOW AS PRACTICABLE. RADIATION SAFETY SURVEYS SHALL BE CONDUCTED PERIODICALLY.
3. OPERATORS SHALL WEAR FINGER-RING AND BODY RADIATION BADGES, AS ASSIGNED BY THE RSO, WHILE USING THE EQUIPMENT.
4. OPERATORS SHALL REMAIN IN CONSTANT ATTENDANCE WHILE THE X-RAY BEAM IS ON, OR THE DEVICE SHALL BE SECURED AGAINST ACCESS BY UNAUTHORIZED PERSONS.
5. ANY CHANGES IN THE STATUS OR LOCATION OF A DEVICE SHALL BE REFERRED TO THE RADIATION SAFETY OFFICER FOR PRIOR APPROVAL.

CHAPTER FIFTEEN

BONE DENSITOMETERS

General Radiation Safety Program

1. Bone densitometers will be surveyed by the Radiation Safety staff at each source loading to ensure that anticipated exposure rates are not exceeded.
 2. All individuals using the devices will be registered with EHS as Radiation Workers. A trial period of personnel radiation monitoring may be put into effect.
 3. The I-125 source exchanges will be made by, or under the supervision of, the Radiation Safety Office in accordance with the manufacturer's instructions. Spent sources will be transferred to radioactive waste or returned to the vendor. Replacement sources shall be ordered, received and processed in accordance with established UNC-CH procedures.
 4. Leak tests of sealed sources will be performed at six-month intervals on sources in use for that period.
 5. Bone densitometers will be maintained and operated in accordance with the manufacturer's instructions. Initial instrument setup and instructions on operation and source changing will be conducted by a licensed representative.
- Transportation Instructions

Radioactive materials must be transported in full accordance with U.S. Department of Transportation (DOT) requirements. Strict adherence to these instructions will ensure that this is done. A copy of these instructions shall accompany each off-campus move. Individuals accompanying radiation source moves shall be familiar with these instructions.

1. Secure the radiation source in the "OFF" position (beam shutter closed).
2. Carefully pack the device components in the transport vehicle to prevent damage in transit and secure in place.
3. The outside of the device component containing the radiation source shall bear the written marking, "RADIOACTIVE" or "CAUTION – RADIOACTIVE MATERIAL".
4. Maintain a log of radiation source movements off the UNC-CH campus, including:
 - a. Date of departure and return
 - b. Location(s) of use
 - c. Name of individual who accompanied on the move and was responsible for off-campus use.
5. The device and shipping container must be surveyed upon return from use in the field to ensure radiation levels do not exceed 200 mrems per hour at the container surface nor 10 mrems per hour at 1 meter.

Emergency Procedures

In the event of a radiation source loss, damage, or other incident, contact the UNC-CH EHS, (919) 962-5507, or Campus Police, (919) 962-6565, immediately. Give information on the circumstances, a contact telephone number and the exact physical location.

In the event of a vehicular accident involving a radiation source, response actions and priorities are:

- a. SAVE LIVES!
- b. Render First Aid
- c. Call for help.
- d. Secure control of any radiation sources
- e. Contact the UNC-CH EHS (919) 962-5507, or Campus Police, (919) 962-6565, as soon as practicable. Describe the circumstances and physical location.

CHAPTER SIXTEEN

NUCLEAR MOISTURE GAUGES

Operating, Transportation and Emergency Procedures

Nuclear gauge design incorporates operator safety as a prime consideration. However, as with any device containing radioactive materials, some general precautions must be observed.

1. Do not operate or attempt to operate the instrument unless you have been trained and authorized to do so.
2. While radiation exposure levels are well within limits for radiation workers, never expose yourself to the source except as necessary in routine operation or emergencies.
3. Keep all unauthorized persons out of the operation area. A suggested distance is 5 meters (15 feet). The general public must not be unnecessarily exposed to radiation.
4. Maintain security of the instrument at all times. The instrument must be kept in a locked vehicle on the job site when not in use. Not only is the gauge an expensive piece of equipment but, if lost or stolen, a potentially hazardous situation to the general public could be created.
5. A Utilization Log must be maintained, containing, at the minimum the following: Date out, Name of Authorized User who used the gauge, Make/Model/Serial Number of the device, Date returned to storage, initials of the person who returned the device.
6. The gauge shall be transported only by an approved operator. During transportation, the gauge shall be packaged in its shipping-storage container, secured and locked in the closed vehicle. The shipping container meets U.S. DOT Type A specifications.
7. The gauge and shipping-storage container must be surveyed upon return from use in the field to ensure radiation levels do not exceed 200 mrem per hour at the container surface nor 10 mrem per hour at 1 meter.
8. When not in use, the gauge will be stored at the UNC-CH Facilities Services, EHS, or other RSO approved location. The gauge will be stored in its shipping container in a locked *space*. The locked space will be keyed separately, with only authorized users having key access.
9. If you have any questions or concerns about use of the instrument, ASK. The Radiation Safety Office is available at 962-5507.
10. If the instrument is damaged in any manner, or fails to function properly, contact the Radiation Safety Office immediately at 962-5507 or through the University Police at 962-6565.

CHAPTER SEVENTEEN

UNC-CH COGENERATION FACILITY NUCLEAR COAL FUEL CONTROL GAUGES

Radiation Safety Procedures

1. Radiation sources and source housing assemblies will be installed and serviced only by Stock Equipment Company or other service company representatives who are specifically licensed to provide such services.
2. During the initial installation, a comprehensive radiation safety survey and source leak test will be performed. Each source will be clearly labeled, CAUTION - RADIOACTIVE MATERIAL, and with a specific description of the radionuclide, activity and date of the activity assay. A controlled area will be established where occupied spaces may exceed 2 millirem in any one hour.
3. Key control of each source housing shutter lock will be exclusively through the individual(s) designated by the UNC-CH Radiation Safety Committee and the UNC-CH Radiation Safety Officer or designee.
4. Any proposed adjustment, relocation or exchange of a source or source housing assembly shall be carried out only under a specific Radiation Work Permit issued by the UNC-CH Radiation Safety Officer or designee.
5. Any entry by an individual into a space intended for the primary radiation source field shall only be under a specific Radiation Work Permit issued by the UNC-CH Radiation Safety Officer or designee. The Radiation Work Permit shall specifically describe how the source shutter is to be locked in the "OFF" position, the pre-entry radiation surveys to be conducted, personnel monitoring to be provided and supervisory conditions for the entry. A UNC-CH Radiation Safety staff member shall be present through each entry.
6. Each source will be surveyed and leak tested every six months by the UNC-CH radiation safety staff. Leak tests will be conducted and evaluated in accordance with the source manufacturer's instructions and UNC-CH Radiation Safety Policies and Procedures.