

Radiation Safety Manual

Policy 303.22

1 Introduction

1.1 Appalachian State University is licensed by the State of North Carolina to use radiation sources in operations, education, and research and development activities. The ASU Radiation Safety Officer may issue individual faculty and staff members an ASU Radiation Use Authorization, 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. The State of North Carolina administers licensing of some radioactive material and registering all x-ray producing machines.

1.2 We would like to thank the University of North Carolina at Chapel Hill and the University of Nevada at Reno for their permission to use portions of their Radiation Safety Manuals.

2 Scope

2.1 This manual summarizes the terms of the University's authorization and the policies most applicable to campus utilization of various radiation sources and x-ray producing machines, such as acquiring, using, and disposing of radioactive material. A copy must be available in each facility where radiation sources are used. Special precautions, regulations, and other operating procedures specified by the Radiation Safety Officer or the State of North Carolina must also be maintained and made available to laboratory personnel. 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).

3 Definitions

3.1 ASU

Appalachian State University

3.2 RSO

Radiation Safety Officer

3.3 ALARA

As Low As Reasonably Achievable

3.4 NCDENR

North Carolina Department of the Environment and Natural Resources DEH Division of Environmental Health; The division of NC DENR that administers radiation protection

3.5 RPS

Radiation Protection Section; The section of the DEH that administers radiation protection

3.6 ASU RUA

Radiation Use Authorization; Permission to use radioisotopes issued by the RSO

3.7 ORP

Office of Research Protections

3.8 Exposure

Amount of radiation deposited in any material measured in ROENTGEN (R) SI Unit is 1 Coulomb of charge deposited per kilogram of mass

3.9 Dose

Amount of energy deposited in any material. Measured in GRAYS (Gy). The older unit is RADS (Radiation Adsorbed Dose) 1 RAD = 10 mGy

3.10 Radiation Rate

Number of disintegrations detected per second. Usually measured in milliroentgens/hr (mR/hr), (counts/min) or microSieverts/hr)

3.11 Exposure Rate

Amount of radiation being deposited in any material. For humans this rate is measured in rems per unit of time.

3.12 REM (Roentgen Equivalent Man)

An old unit for the amount of radiation dose absorbed by an individual that does actual biological damage. New unit is Sieverts (Sv). 1 Sv = 0.01 rem.

3.13 Specific License

Approval issued by the State of North Carolina to possess and use certain radioisotopes

3.14 Registration Approval

Issued by the State of North Carolina to possess and use x-ray generating equipment

[North Carolina Regulations for Protection Against Radiation](#)

4 Policy and Procedure Statements

4.1 Administration

4.1.1 The ASU Radiation Safety Program

- a. The Appalachian State University (ASU) Radiation Safety Program shall administer the procedures and engineering controls to achieve occupational doses to researchers, students, and the general public and releases of radioactive materials that are As Low As Reasonably Achievable (ALARA).
- b. The ASU Radiation Safety Program shall be reviewed annually by the ASU Radiation Safety Officer (RSO) for program content and proper implementation of procedures in accordance with 15A NCAC 11, North Carolina Regulations for Protection Against Radiation.
- c. The Radiation Safety Program described in this document applies to the use of radioisotopes and x-ray producing machines by academic ASU faculty and staff.

4.1.2 The ASU Radiation Safety Council

- a. The Radiation Safety Council shall consist of faculty and staff members with experience using radioactive materials or ionizing radiation producing devices, or with an interest in safety. The Council shall be appointed by the Chancellor for two and three year terms. The purpose of the Council shall be to ensure that the radiation usage at ASU is conducted in accordance with ALARA and at the lowest risk possible to the University community.
- b. The Radiation Safety Council is responsible for the following:
 1. Review and recommendations concerning policies and procedures governing the use of radioactive materials and radiation-producing devices. A majority vote of a quorum will be required to approve an agenda item.
 2. Assist with the preparation and compilation of a Radiation Safety Program operations and performance audit when requested by the RSO.
 3. Provision of professional advice to the Chancellor or a designee regarding the RSO's qualifications and performance.

4. Provision of professional advice to the RSO on matters regarding radiation safety.

4.1.3 The ASU Radiation Safety Officer

- a. The Radiation Safety Officer shall be that person appointed by the University and acceptable to NC DENR Radiation Protection Section as qualified to implement the ASU Radiation Safety Program and to advise University members on safety matters pertaining to ionizing radiation.
- b. The ASU RSO holds the Specific License on which all licensable quantities of radioactive materials are listed.
- c. Responsibilities of the Radiation Safety Officer shall be to:
 1. Establish and oversee University operating safety, emergency, and ALARA procedures and review them annually to ensure that the procedures are current and conform to 15A NCAC 11 regulations.
 2. Administer ASU's Specific License.
 3. Administer ASU's radiation training program.
 4. Act as liaison between ASU and NCDENR/RPS.
 5. Review and issue final approval of applications for Radiation Use Authorizations.
 6. Review and issue final approval of applications for acquiring radioactive material.
 7. Prepare applications for and amendments to radioactive materials licenses and ionizing radiation producing registrations, as submitted to the NCDENR/RPS.
 8. Assist in the applications for and amendments to ionizing radiation producing registrations, as submitted to the NCDENR/RPS.
 9. Provide records to the Office of Research Protections for record keeping as required by 15A NCAC 11 regulations.
 10. Ensure that personnel are complying with these rules, and the conditions, safety and emergency procedures of the ASU Specific License.
 11. Ensure that operators of x-ray producing machines are complying with these rules, and the conditions, safety and emergency procedures of their registration.
 12. Provide assistance to the hazardous waste disposal program for radioactive materials.
 13. Ensure that required radiation surveys and leak tests are performed and documented in accordance with the terms of the license, including corrective measures when levels of radiation exceed established limits.
 14. Ensure that personnel monitoring is used properly by occupationally exposed personnel, that records are kept of the monitoring results, and that timely notifications are made as required by regulatory entities.
 15. Ensure the proper storing, labeling, transport, and use of sources of radiation, storage, and/or transport containers.
 16. Ensure that inventories are performed in accordance with the activities for which the license application is submitted.
 17. Assume control and have the authority to institute corrective actions, including shutdown of operations when necessary in emergency situations or unsafe conditions.
 18. Investigate and submit appropriate documentation to NCDENR/RPS for each known or suspected case of radiation exposure to an individual or radiation level detected in excess of limits established by these rules and each theft or loss of source(s) of radiation, to determine the cause(s), and to take steps to minimize a recurrence.
 19. Investigate and submit a report to the appropriate Agency for each known or suspected significant case of release of radioactive material(s) to the environment.
 20. Coordinate with the applicable University departments and groups (Public Safety and Risk Management, Occupational Safety and Health Department, etc.) to ensure that the radiation safety program is operating within the scope of University-wide safety and security initiatives.

4.1.4 The ASU Office of Research Protections

- a. The Office of Research Protections shall be the unit responsible for providing administrative support to the RSO and Radiation Safety Council.
- b. Responsibilities of the Office of Research Protections are:
 1. Process applications for licenses, registrations, and other State documents.
 2. Provide administrative support to the RSO and Radiation Safety Council.
 3. Have knowledge of management policies and administrative procedures of the license.
 4. Ensure that records are maintained as required by 15A NCAC 11 regulations.

c. North Carolina Department of Environment and Natural Resources / Radiation Protection Section

NCDENR/RPS is the State agency responsible for enforcing policy pertaining to radioactivity and administering radioactive materials and x-ray producing machines. The North Carolina statute which regulates radioactive materials is 15A NCAC 11, Regulations for Protection Against Radiation.

4.2 Radiation Protection Principles

4.2.1 Radiation Exposure Basics

- a. The body may be irradiated in two ways: externally from radioactive material or radiation sources, or internally from radioactive material deposited in the body.
- b. External (radiation) 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:
- c. **Exposure:** Exposure depends on the activity of the radiation source (events occurring per second) (Curies (Ci) or Becquerals (Bq)) or the intensity (the number of radiation events being produced per second by a radiation producing machine. By reducing the amount of radioactive material used or lowering the settings on a radiation-producing machine, dose can be reduced.
- d. **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.
- e. **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.
- f. **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 (radiation) doses result from the absorption, ingestion or inhalation of radioactive material. This material can be incorporated in the body in several ways:
1. Breathing radioactive gases, vapors or dust.
 2. Consuming radioactive material transferred from contaminated hands, tobacco products, food, or drink.
 3. Entering through a wound.
 4. Absorption through the skin.
- g. The fundamental objectives of radiation protection measures are:
1. To limit exposure from external radiation to levels that are as low as reasonably achievable and always within the established dose limits.
 2. 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.
- h. When these objectives have been met, it is practicable to use radiation sources for academic, development, research and clinical procedures.

4.2.2 General Radiation Safety Laboratory Guidelines for Radioactive Material Use

1. The procedure for each project shall be well outlined in writing for all laboratory personnel. Necessary equipment, waste containers, and survey instruments shall be available.
2. Characteristics of the radioactive material such as type of radiation, energy, half-life, significant and typical amounts, and chemical form shall be documented.
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. An ASU Approved User (see Section 3) should supervise students and visitors in a laboratory that uses radioactive material.
5. Radioactive material shall 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 shall be locked when unattended.
6. Work with radioactive material shall 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 shall 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.
12. Never pipette by mouth suction. Always use a mechanical pipette filling device.

13. Refrigerators used to store radioactive material must not be used for the storage of food. All storage compartments (refrigerator and freezer sections) must be conspicuously posted with radiation warning stickers.
14. Refrigerators used for food storage must be posted as "FOOD STORAGE AREA - NO HAZARDOUS SUBSTANCES ALLOWED."
15. Wash hands thoroughly after working with or near radioactive materials and before eating, drinking, smoking, or applying cosmetics.
16. Protective gloves shall 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.
17. Lab coats and appropriate shoes should be worn by all individuals handling radioactive material.
18. 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.

4.2.3 Eating, Drinking and Smoking Policies

- a. Appalachian State University prohibits smoking inside its buildings and facilities as well as in outdoor areas controlled by the University within 50 feet of University facilities. Smoking is not permitted within laboratory areas.
- b. 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. **No food items are allowed in laboratories where radioactive materials are used.**
- c. The following rules regarding food are to be observed:
 1. 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 the RSO. 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 containers, dishes, and utensils are to be washed only in a sink exclusively designated for food utensils. Laboratory glassware or equipment is to be washed in separate sinks. Glassware or utensils that have been used for laboratory operations cannot be used for food or beverages.
 2. 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.
 3. Designated food item areas must be free from all research-related items including personal protective equipment.
 4. Absolutely no chemical or radioactive materials storage is allowed above any designated food items area.

4.2.4 General Radiation Safety Laboratory Guidelines 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 RUA holder (See Section 3).
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 NCDENR/RPS 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 should 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. 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 NCDENR/RPS.

4.3 Appalachian State University Radiation Safety Procedures

4.3.1 The procedures described in the following section represent a subset of 15A NCAC 11, North Carolina Regulations for Protection Against Radiation. These procedures are intended to be consistent with State regulations; however, if a discrepancy exists, these procedures defer to State regulations.

4.3.2 Appalachian State University is licensed by the State of North Carolina to possess and use radioactive material. Radioisotopes whose activity exceeds the threshold listed in Appendix C shall be included in this license. In addition, the RSO shall maintain a list of all academic campus users of radioactivity (including x-rays) and an inventory of all radioactive material purchased, possessed and used by its faculty.

4.3.3 The ASU Radiation Use Authorization

- a. Any academic faculty or staff member who wishes to order, purchase, possess or use radioisotopes or x-ray producing machines shall obtain a Radiation Use Authorization (RUA). Any research assistant who plans to use radioactivity for a period of time longer than one month under the direction of an ASU faculty or staff member shall obtain an RUA. The RSO is responsible for issuing an RUA. The RUA is an internal designation and not recognized by the State of North Carolina.
- b. To be granted an RUA the applicant must complete the following steps:
 1. Obtain from, complete, and submit to the RSO the form Application for Radiation Use Authorization.
 2. Complete safety training and demonstrate adequate knowledge of radioactivity and safety as described in Section 3.2. This requirement must be met before an RUA is issued. For isotopes with activities determined to be below the threshold for State licensing (see Appendix C), the RSO will, upon completion of the application and successful demonstration of adequate radioactive training and knowledge, review the application and, if appropriate, issue the RUA.
- c. If the requested radioisotope activity exceeds the threshold for State licensing, then
 1. The applicant shall assist the RSO in preparing and submitting to NCDENR/PRS an amendment to the ASU Specific License to include the new radioisotope. After the amendment has been accepted by the State of North Carolina then the RSO will issue the RUA.
- d. For a requested x-ray producing machine,
 1. The applicant shall, with the RSO's assistance, prepare and submit to NCDENR/RPS an application for an x-ray producing machine registration. After the application has been accepted by the State of North Carolina then the RSO will issue the RUA.
- e. A faculty or staff member who possesses an RUA is responsible for the safe use of their radioisotopes and/or x-ray producing machines and strict compliance with the contents of this Manual, the provisions and requirements of 15A NCAC 11, North Carolina Regulations for Protection Against Radiation, and when appropriate the provisions and requirements of the ASU Specific License.
- f. The Radiation Use Authorization obliges the holder to:
 1. Follow procedures for obtaining and maintaining the RUA.
 2. Comply with terms and conditions specified in the RUA.
 3. Follow procedures for procurement and disposal of radioactive materials and radiation producing devices.
 4. Notify the RSO of any need for changes in the approved use of radioactive materials or registered equipment, including but not limited to changes in use, location, possession limit, and approved users, and termination of RUA.
 5. Assist the RSO in preparation and submission of documentation required by NCDENR/RPS.
 6. Preparation of reports as requested by the RSO.
 7. Arrange for appropriate actions with the RSO in the event of anticipated inactivity or extended absence from ASU.
 8. Establish and maintain a culture for radiation safety awareness in the workplace. This shall include control of radiation exposure to the lowest reasonable level (ALARA)
 9. Ensure that all users of radiation are properly trained on specific radioactive materials/radiation producing devices usage protocols, nuclide safety data sheets, emergency procedures and security requirements within their area of accountability.
 10. Display the RUA prominently in the laboratory in which the radioisotope is being used.
 11. Provide correct and current signage of laboratory areas and radioactive material containers.
 12. Perform radiation and contamination monitoring as required by applicable regulations and procedures in this manual. Maintain accurate records of such monitoring results
 13. Ensure maintenance of accurate and current inventory records for all radioactive materials on the RUA.
 14. Immediately report any potentially hazardous spills, suspected radiation overexposures, loss or theft of radioactive materials, or other incidents having possible radiation safety implications on the ASU Incident/Accident Form to the RSO.
 15. Complete annual reporting on the ASU RUA Annual Reporting Form, available from the RSO.

g. In addition, users of State licensed sources must comply with the conditions established in the ASU Specific License.

4.3.4 Radiation Safety Training

4.3.4.1 All users of radioactivity at ASU shall be familiar with the principles of radioisotope physics and chemistry, hazards, and safety.

4.3.5 Applicants for a new Radiation Use Authorization

4.3.5.1 A complete application for an RUA shall include attendance at radiation protection/health physics training conducted or approved by the RSO within the previous year, and a passing score (greater than or equal to 70%) on a radiation protection/health physics exam administered and approved by the RSO.

4.3.6 RUA Renewal

4.3.6.1 Current ASU Approved Users shall retrain annually, as described above. Failure to document retraining after two notifications may result in a revocation of the user's RUA.

4.3.7 Research Assistants Working for a Faculty or Staff Holding an RUA

a. Temporary users of radioisotopes (radiation use period less than or equal to one month) must be trained by their supervisor in relevant radiation protection policies and procedures, and be directly supervised (the faculty or staff holding the RUA must be in the laboratory when this worker is using the radioisotope). ASU Radiation Safety Training is recommended but not mandatory. The supervising RUA holder shall document the radiation safety training that was provided. Documentation of this training must be kept in the appropriate work area and be readily accessible.

b. Research assistants who plan to use radioactivity for more than one month shall successfully complete RUA training. In addition, the supervising faculty or staff member may provide and document additional training specific to the particular laboratory setting. Research assistants may not purchase radioactive material.

4.3.8 Students

4.3.8.1 Classroom use training requirements for ionizing radiation can be met by either the RUA holder or the RSO presenting to the class a summary of radiation safety guidelines commensurate with the level of radioactivity prior to the laboratory work. Documentation of this training must be maintained by the supervising RUA holder.

4.3.9 Acquisition of Radioactive Materials

4.3.9.1 Only an ASU faculty or staff member with an RUA may acquire radioactive material. An Application for New Radioactive Material shall be completed and approved prior to ordering or receiving of the material. Faculty or staff obtaining gratis radioactive materials must complete the Application for New Radioactive Material. Additionally, the material shall be received by the RSO.

4.3.10 Acquisition of X-ray Producing Machines

4.3.10.1 A faculty or staff member desiring to purchase an x-ray producing machine shall complete the Application for New X-Ray Producing Machines. All x-ray producing devices must be registered by the State of North Carolina. This application shall be completed by the applicant in collaboration with the RSO.

4.3.11 Radioactive Waste Disposal

4.3.11.1 A faculty or staff member with an RUA who has a radioactive waste disposal need shall complete the Application for Disposal of Radioactive Material. Where appropriate, Authorized Users shall comply with the terms of the ASU Specific License in regards to disposal of radioactive waste.

4.3.12 Emergency Procedures

4.3.12.1 An emergency or accident will require varying degrees of action depending on the type and severity of the emergency. While the radioactive sources and x-ray producing machines currently in use at ASU constitute a minimal hazard, users are expected by ASU and required by law to be diligent in reducing exposure and reporting any exposure. The initial handling of such an event rests with either the person directly involved or the person first alerted to the situation. Much of what follows is of general applicability in any radiation emergency.

4.3.13 Prepare Before an Emergency Occurs

4.3.13.1 Any faculty or staff member with an RUA must become familiar with ASU emergency plans and policies. Information is available at <http://emergency.appstate.edu>, or by contacting the Office of Emergency Plans and Operations and x8081.

4.3.14 Evaluate the Emergency and Call for Help

4.3.14.1 The first person to observe the emergency should try to quickly estimate the severity of the situation and evacuate personnel from the immediate area. For larger emergencies, the first person to observe the emergency should utilize the nearest fire alarm pull station to initiate an evacuation of the building. One person must notify the University Police Department and/or fire department upon their arrival of the nature of the incident. The Radiation Safety Officer and the facility/laboratory supervisor should be notified as soon as possible. Report all emergencies that threaten life or property to on-campus police at x8000.

4.3.15 Confine The Hazard

4.3.15.1 If possible, secure the area and stand by to provide information and assistance. Reduce the spread of contamination by limiting travel from the area and by checking shoes for contamination if practicable.

4.3.16 Protect Personnel

4.3.16.1 Warn other persons in the immediate vicinity and assist any persons who may be contaminated or injured. NOTE: Emergency action personnel who have been notified will take over after this first phase of the emergency. They will prescribe additional action to be taken and begin restoration to normal operating conditions.

4.3.17 Reporting

4.3.17.1 It is the responsibility of the faculty or staff member holding the RUA to complete and submit to the RSO an ASU Incident/Accident Report. In addition, faculty or staff RUA holder, in collaboration with the RSO, will determine if State reporting is appropriate and file the report.

4.3.18 Injuries

4.3.18.1 Any time an employee's injury or overexposure requires medical evaluation or attention, the Worker's Compensation guidelines at <http://www.hrs.appstate.edu> must be followed.

4.4 Instruments Containing Radioactive Materials

4.4.1 Sealed sources used in instrumentation, for example ECD (Electron Capture Detector) and SMPS (Scanning Mobility Particle Sizer) detectors, while often below the threshold for State licensing (i.e., are generally licensable), shall be included on ASU's specific license. Any faculty or staff member wishing to purchase an instrument containing a sealed source shall submit an Application for New Radioactive Material.

4.4.2 Sealed sources require a periodic wipe test and inventory, both of which shall be conducted by the RSO.

4.5 Radiation Producing Machines

4.5.1 All x-ray producing machines shall be registered with the State of North Carolina. Any faculty or staff member who wishes to purchase or operate such a device shall submit an Application for New X-Ray Producing Machines to the RSO.

4.5.2 Monitoring and Control

1. Each user shall inform individuals working in or frequenting any portion of a restricted area of the occurrence of radiation or sources of radiation in the area through the posting of a standard form "Notice To Employees".
2. All machines or devices shall be labeled in a manner which cautions individuals that radiation is produced when the machine is operated.
3. Utilization logs must be kept currently available for inspection by the Radiation Protection Branch (RPB).

4.5.3 Shielding

1. With equipment operating above 125 kVp, the required protective barriers provided for all wall, floor and ceiling areas that can be struck by the useful beam shall be an integral part of the building.

2. With equipment operating above 150 kVp, the control station shall be within a protective booth or outside the treatment room.
3. X-Ray therapy equipment operated at potentials of 60 kV and below shall have on the control panel some easily discernible device which will give positive information as to whether or not the tube is energizing.
4. Machines having an output of more than 1,000 roentgens per minute at any accessible place shall not be left unattended without the power being shut off at the primary disconnecting means.

4.5.4 Personnel Safety Rules

1. Safety glasses, personal eye glasses or other appropriate eye protection devices shall be worn at all times when working with low energy output X-ray apparatus.
2. Follow ALL safety requirements outlined in the specific laboratory X-ray operating manual pertaining to the X-ray machine that will be used. If you have any questions or reservations about how to properly operate the machine and minimize risk, contact the Principal Investigator of the X-ray before using the machine.
3. Current knowledge of the various radiation levels at all places around the X-ray apparatus shall be maintained.
4. Port closures should be double checked before moving the beam stop, collimator on the main body of an instrument, or before changing a specimen.
5. Persons should be especially careful about keeping their fingers out of the main beam, especially when making adjustments on goniometer heads. It is often best to keep one's hands on the X-ray tube side of the goniometer to prevent some part of the hand from drifting, unnoticed, into the beam. Use of a fluoroscopic detector is recommended.
6. When changing the equipment configuration or equipment alignment relative to an energized X-ray tube, the radiation field shall be continuously monitored with a survey meter.

5 Additional References

5.1 [Download Radiation Safety Forms](#)

5.2 The State of North Carolina regulates the use of radioactive materials whose activity exceeds a given threshold. Listed below are the activity thresholds for specific isotopes as given by the state. (See 15A NCAC 11 .0304). Appalachian State University regulates all radioisotopes regardless of activity level.

Radioactive Material	Microcuries	Radioactive Material	Microcuries
Antimony 122 (Sb 122)	100	Gadolinium 159 (Gd 159)	100
Antimony 124 (Sb 124)	10	Gallium 67 (Ga 67)	100
Antimony 125 (Sb 125)	10	Gallium 72 (Ga 72)	10
Arsenic 73 (As 73)	100	Germanium 71 (Ge 71)	100
Arsenic 74 (As 74)	10	Gold 198 (Au 198)	100
Arsenic 76 (As 76)	10	Gold 199 (Au 199)	100
Arsenic 77 (As 77)	100	Hafnium 181 (Hf 181)	10
Barium 131 (Ba 131)	10	Holmium 166 (Ho 166)	100
Barium 133 (Ba 133)	10	Hydrogen 3 (H 3)	1,000
Barium 140 (Ba 140)	10	Indium 111 (In 111)	100
Bismuth 210 (Bi 210)	1	Indium 113m (In 113m)	100
Bromine 82 (Br 82)	10	Indium 114m (In 114m)	10
Cadmium 109 (Cd 109)	10	Indium 115m (In 115m)	100
Cadmium 115m (Cd 115m)	10	Indium 115 (In 115)	10
Cadmium 115 (Cd 115)	100	Iodine 123 (I 123)	100
Calcium 45 (Ca 45)	10	Iodine 125 (I 125)	1
Calcium 47 (Ca 47)	10	Iodine 126 (I 126)	1
Carbon 14 (C 14)	100	Iodine 129 (I 129)	0.1
Cerium 141 (Ce 141)	100	Iodine 131 (I 131)	1
Cerium 143 (Ce 143)	100	Iodine 132 (I 132)	10

Cerium 144 (Ce 144)	1	Iodine 133 (I 133)	1
Cesium 129 (Cs 129)	100	Iodine 134 (I 134)	10
Cesium 131 (Cs 131)	1,000	Iodine 135 (I 135)	10
Cesium 134m (Cs 134m)	100	Iridium 192 (Ir 192)	10
Cesium 134 (Cs 134)	1	Iridium 194 (Ir 194)	100
Cesium 135 (Cs 135)	10	Iron 52 (Fe 52)	10
Cesium 136 (Cs 136)	10	Iron 55 (Fe 55)	100
Cesium 137 (Cs 137)	10	Iron 59 (Fe 59)	10
Chlorine 36 (Cl 36)	10	Krypton 85 (Kr 85)	100
Chlorine 38 (Cl 38)	10	Krypton 87 (Kr 87)	10
Chromium 51 (Cr 51)	1,000	Lanthanum 140 (La 140)	10
Cobalt 57 (Co 57)	100	Lutetium 177 (Lu 177)	100
Cobalt 58m (Co 58m)	10	Manganese 52 (Mn 52)	10
Cobalt 58 (Co 58)	10	Manganese 54 (Mn 54)	10
Cobalt 60 (Co 60)	1	Manganese 56 (Mn 56)	10

6 Authority

7 Contact Information

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NCDENR/RPS Contact:

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[Radiation Safety Program Forms are available on the Office of Research Protections website](#)

Application for Radiation Use Authorization
Application for New Radioactive Material
Application for New X-Ray Producing Machines
Application for Disposal of Radioactive Material
ASU RUA Annual Reporting Form
ASU Radiation Laboratory Safety Rules
Radiation Incident/Accident Report
Sealed Source Wipe Test Report
Sealed Source Inventory Report

8 Original Effective Date

December 1, 2010

9 Revision Dates

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