



**RADIATION SAFETY MANUAL
WRIGHT STATE UNIVERSITY
DAYTON, OHIO**

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Quick References:

Radioactive Materials: Decontamination/Emergency Response (p. 29)

Radiation Generating Equipment: Emergency Response (p. 47)

For emergency support from the Radiation Safety Office after normal working hours, call the WSU Police Dispatcher, 937-775-2111 (or 911 on the main campus) and ask them to call Kimberly Morris or the “On-Call” EH&S representative of the Environmental Health and Safety Department.

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***Signatures on File in the Radiation Safety Office**

TABLE OF CONTENTS

Page

I. ADMINISTRATION OF THE RADIATION SAFETY PROGRAM

1.0	FOREWORD.....	1
1.1	UNIVERSITY RADIATION SAFETY COMMITTEE	2
1.1.1	COMMITTEE RESPONSIBILITIES.....	2
1.2	UNIVERSITY RADIATION SAFETY OFFICER.....	3
1.2.1	RADIATION SAFETY OFFICER RESPONSIBILITIES.....	3
1.3	REGULATORY COMPLIANCE	4
1.4	ALARA GOALS.....	5
1.5	RADIATION DOSE LIMITS.....	6
1.5.1	Occupational Dose Limits	
1.5.2	Dose Limits for Members of the Public	
1.6	DOSIMETRY ISSUANCE	7
1.6.1	Dosimeter Types	
1.6.2	Dosimetry Issuance	
1.6.3	Lost or Damaged Dosimeters	
1.6.4	Internal Exposure Monitoring	
1.6.5	Dosimetry Records and Reports	

II. USE OF RADIOACTIVE MATERIALS (YELLOW SECTION)

2.1	AUTHORIZED USER.....	9
2.1.1	Qualifications	
2.1.2	Responsibilities	
2.2	INDIVIDUAL USER.....	11
2.2.1	Qualifications	
2.2.2	Responsibilities	
2.3	VISITOR USER.....	13
2.3.1	Qualifications	
2.3.2	Responsibilities	
2.4	SUPERVISED USER.....	14
2.4.1	Qualifications	
2.4.2	Responsibilities	
2.5	TRAINING FOR NON-USERS.....	14
2.6	EXPERIMENTAL USE AUTHORIZATIONS	15
2.6.1	Use Authorization Applications	
2.6.2	Use Authorization Changes	
2.6.3	Use Authorization Suspension	
2.6.4	Use Authorization Termination	
2.7	GENERAL PRECAUTIONS.....	17
2.8	EXTERNAL EXPOSURE PROTECTIVE MEASURES	18
2.8.1	Time	
2.8.2	Distance	
2.8.3	Shielding	
2.8.4	Precautions when Using ^{32}P in Millicurie Amounts	18

TABLE OF CONTENTS

	Page
2.9 INTERNAL EXPOSURE PROTECTIVE MEASURES	19
2.9.1 Personal Protection	
2.9.2 Protection from Airborne Contaminants	
2.9.3 Annual Limit on Intake (ALI)	
2.10 WORK AREA PROTECTION	20
2.11 PURCHASING RADIOACTIVE MATERIALS	21
2.12 RECEIPT OF RADIOACTIVE MATERIALS	21
2.12.1 Receipt by Radiation Safety Office	
2.12.2 Package Receipt Procedures	
2.13 LOCATIONS OF USE	22
2.13.1 Licensed Locations	
2.13.2 Approved Use Locations	
2.14 INVENTORY OF RADIOACTIVE MATERIALS	23
2.14.1 Inventory Cards	
2.14.2 Central Inventory	
2.14.3 Inter-Laboratory Transfer of Radioactive Materials	
2.15 TRANSPORT (SHIPMENTS) OF RADIOACTIVE MATERIAL	24
2.16 SECURITY	24
2.17 POSTING AND LABELING WARNING SIGNS	24
2.17.1 Posting Lab Entryways	
2.17.2 Use Area and Equipment Labels	
2.17.3 Radioactive Waste Labels	
2.17.4 Sign/Label Acquisition	
2.18 SURVEYS FOR CONTAMINATION	26
2.18.1 Surveys for Removable Contamination	
2.18.2 Survey Meter Monitoring	
2.18.3 Releasing Equipment for Repair or Unrestricted Use	
2.18.4 Releasing Laboratories for Unrestricted Use	
2.19 RADIOACTIVE SPILLS / EMERGENCY RESPONSE	29
2.19.1 Response to Minor Spills (<1 mCi)	
2.19.2 Response to Major Spills (>1 mCi)	
2.19.3 Facility Decontamination	
2.19.4 Personal Decontamination	29
2.19.5 Medical Emergencies	31
2.20 BIOASSAYS FOR INTERNAL EXPOSURE	32
2.21 IODINATION PROCEDURES	32
2.21.1 Radioimmunoassay (RIA) Kits	
2.21.2 Iodination Procedures	
2.22 SEALED RADIOACTIVE SOURCES	34
2.22.1 Leak Tests of Sealed Sources	
2.22.2 Gas Chromatography Equipment	
2.23 ANIMAL USAGE INVOLVING RADIOACTIVE MATERIALS	34

TABLE OF CONTENTS

	Page
2.24 RADIOACTIVE WASTE	35
2.24.1 Containment and Labeling of Waste	
2.24.2 Documentation	
2.24.3 Waste Minimization	
2.24.4 Solid Waste.....	36
2.24.5 Liquid Waste	37
2.24.6 Liquid Scintillation Vials	37
2.24.7 Decay-in-Storage.....	38
2.24.8 Animal Waste	
2.24.9 Mixed Waste	
2.24.10 Infectious Waste	
 III. RADIATION GENERATING EQUIPMENT (GREEN SECTION)	
3.0 INTRODUCTION	40
3.1 FACILITY COORDINATOR	40
3.1.1 Qualifications	
3.1.2 Responsibilities	
3.2 FACULTY USER.....	42
3.2.1 Qualifications	
3.2.2 Responsibilities	
3.3 FACILITY OPERATOR	44
3.3.1 Qualifications	
3.3.2 Responsibilities	
3.4 MEDICAL OPERATOR.....	45
3.4.1 Qualifications	
3.4.2 Responsibilities	
3.5 STUDENT OPERATOR.....	47
3.6 EMERGENCY RESPONSE.....	47
3.7 THE ACQUISITION OF RADIATION-GENERATING EQUIPMENT	48
3.8 TRAINING REQUIREMENTS.....	48
3.9 TRAINING FOR ADMINISTRATORS, COLLABORATORS, AND VISITORS	48
3.10 TRAINING FOR SCANNING ELECTRON MICROSCOPES AND PHOTOELECTRON SPECTROMETERS.....	48
3.11 EXPERIMENTAL USE AUTHORIZATIONS.....	49
3.11.1 Use Authorization Applications	
3.11.2 Use Authorization Changes	
3.11.3 Use Authorization Suspension	
3.11.4 Use Authorization Termination	
3.12 PROTECTIVE MEASURES FROM EXPOSURE.....	51
3.12.1 Time, Distance, and Shielding	
3.12.2 General Precautions When Using Radiation-Generating Equipment	
3.12.3 Additional Precautions for Medical Radiation-Generating Equipment	
3.13 LOCATIONS OF USE.....	52

TABLE OF CONTENTS

	Page
3.14 FACILITY OPERATING PROCEDURES.....	53
3.15 USE LOG.....	53
3.16 TESTING OF SAFETY DEVICES.....	54
3.16.1 Routine Testing	
3.16.2 Safety Device Failure	
3.16.3 Safety Device By-Pass	
3.17 MAINTENANCE AND REPAIRS	54
3.18 SECURITY.....	55
3.19 POSTING AND LABELING WARNING SIGNS	55
3.19.1 Posting at Lab Entryways	
3.19.2 Warning on Control Panels	
3.20 VENTILATION.....	56
3.21 EXPOSURE RATE MONITORING.....	56
3.22 FACILITY EVALUATIONS.....	57
3.23 DISPOSAL OF RADIATION-GENERATING EQUIPMENT.....	57

II. USE OF RADIOACTIVE MATERIALS

2.1 AUTHORIZED USER

An Authorized User is a departmentally affiliated member of Wright State University, including adjunct faculty, authorized by the Radiation Safety Committee to use radioactive material independently and supervise subordinate users (i.e., Individual, Visitor, and Supervised Users). The use shall fully comply with research Use Authorizations approved by the committee. An Authorized User is responsible for the safe use and storage of radioactive materials in his/her laboratory, including usage by anyone under his/her direction and protection of non-users. Additionally, the Authorized User shall ensure that subordinate users have proper training to safely perform each assigned task and respond appropriately to emergency situations. Research Use Authorizations must be submitted to the Radiation Safety Officer for Radiation Safety Committee approval before using radioactive materials.

2.1.1 AUTHORIZED USER QUALIFICATIONS

A prospective Authorized User must apply to the Radiation Safety Committee for approval. The applicant shall submit his/her training and experience on Form RSO1. The Authorized User must:

- a) Possess at least a bachelor's degree in the physical or biological sciences;
- b) Have 40 hours of training and experience using radioactive materials. The experience should be using material similar to that proposed for use with regard to the laboratory techniques, possible hazards, and necessary precautions.
- c) Possess a Radiation Safety Manual and review the manual with the Radiation Safety Officer, paying close attention to Authorized User responsibilities and other issues relevant to radiation safety.

The Authorized User's experience with radioactive materials should be reasonably current. The Radiation Safety Committee will judge the adequacy and recentness of experience on a case-by-case basis.

An applicant who is otherwise qualified may gain experience using radioactive material as an Individual User under the supervision of a qualified Authorized User. Upon written recommendation by the supervising Authorized User, the committee may upgrade the applicant's status to Authorized User.

2.1.2 AUTHORIZED USER RESPONSIBILITIES

- a) Order and possess only the types and quantities of radioactive materials for which the Authorized User has approval by the Radiation Safety Committee. Obtain approval from the Radiation Safety Office before procurement.
- b) Ensure that all personnel who enter the Authorized User's laboratory adhere to Use Authorization specifications, the safety rules and regulations recorded in this manual, and any other communications from the Radiation Safety Officer or Radiation Safety

Committee.

- c) Instruct subordinate users on safe practices and responsibilities in the lab. The instruction must include relevant sections of the Radiation Safety Manual. Training documented on [Laboratory Hazard Instruction Form](#) (or equivalent) is required for persons who are likely to receive a radiation dose of 100 mrem per year or more.
- d) Plan and rehearse procedures for radioactive material use to recognize equipment needs, keep radiation exposures As Low As Reasonably Achievable (ALARA), and prepare for unforeseen situations.
- e) Keep Use Authorizations current as procedures and users change. Send updated information to the Radiation Safety Officer by memorandum. Review all current Use Authorization(s) for accuracy and any change that may influence radiation safety at least annually.
- f) Restrict usage of radioactivity to only those materials and users who have received training commensurate with the proposed usage.
- g) Inform the [Radiation Safety Officer](#) immediately of radiation related accidents, spills that limit use of the lab or expand into unrestricted areas, personal contamination, or loss of radioactive materials, even if these incidents occur after normal working hours.
- h) Ensure subordinate users have appropriate dosimetry devices (OSLDs, finger rings) and check regularly on their use. Also, coordinate with the Radiation Safety Officer to ensure that bioassays are performed when necessary.
- i) Maintain proper records of use, transfer, and disposal of radioactive material.
- j) Correct and inform the Radiation Safety Officer of any observed deficiencies or potential problems related to radiation safety.
- k) Utilize safe measures to minimize radioactive waste. Minimize the storage of radioactive material in laboratories by experimental design and purchase management.
- l) Adopt adequate measures for security and control of radioactive material against tampering, loss, theft or unauthorized removal from laboratories or storage areas.
- m) Ensure the laboratory use and storage areas and containers are properly labeled.
- n) Coordinate the activities of housekeeping and physical plant staff to assure their protection while they are providing services in restricted use and storage areas.
- o) Survey for contamination by performing swipes for removable contamination and monitoring with a survey meter at required or appropriate intervals after using unsealed radioactive materials.
- p) Decontaminate after spills that occur within areas of responsibility and report such incidents to the Radiation Safety Officer.

- q) Ensure the Radiation Safety Office surveys all equipment and lab spaces that may be contaminated before they are released for repair, disposal, or unrestricted use.
- r) Arrange for a qualified Authorized User to assume responsibility for ordering materials and general supervision of projects and users during prolonged absences, e.g., sabbatical. Inform the Radiation Safety Officer of plans and arrangements.
- s) Keep the Radiation Safety Manual accessible to users.
- t) Renew Use Authorizations every five (5) years.
- u) Complete the [Safe Use of Radioactive Materials](#) initial training, and refresher training, annually.

2.2 INDIVIDUAL USER

An Individual User is a departmentally affiliated member of the university, who uses radioactive materials under the direction of an Authorized User with a limited degree of supervision. The Individual User is responsible for the safe performance of his/her own activities. The Individual User can assist the Authorized User in training new users in the lab. An Authorized User must apply to the Radiation Safety Committee to add a person to his/her Use Authorization as an Individual User. The Radiation Safety Committee grants approval of Individual User status based on education and experience and recommendation from the Authorized User. Subject to Radiation Safety Committee review, the Radiation Safety Officer may approve persons who are clearly qualified.

2.2.1 INDIVIDUAL USER QUALIFICATIONS

Applicants with Prior Experience. The Authorized User must:

- a) Submit the prospective Individual User's training and experience on Form RSO1 to the Radiation Safety Officer.
- b) Provide specific training on laboratory procedures, radiation hazards, rules and regulations, and user responsibilities. This training must be documented on the [Laboratory Hazard Instruction form](#) (or equivalent) if the person will likely receive a radiation dose of 100 mrem/year or more. Completion of [the Safe Use of Radioactive Materials](#) course is required.
- c) Provide direct (observed) supervision during all use procedures until the Authorized User is confident that the prospective Individual User can work independently. The period of supervision should be commensurate with the person's experience.
- d) Add the Individual User to the Authorized User's authorization by [memorandum to the Radiation Safety Officer](#).

Applicants without Experience. The Authorized User must:

- a) Ensure the prospective Individual User completes the [Safe Use of Radioactive Materials](#) training.
- b) Provide specific training on laboratory procedures, radiation hazards, rules and regulations, user responsibilities, and emergency procedures. This training must be documented on the [Laboratory Hazard Instruction form](#) (or equivalent) if the person will likely receive a radiation dose of 100 mrem/year or more.
- c) Provide direct (observed) supervision during all use procedures until the Authorized User is confident that the prospective Individual User can work independently. The period of supervision should be commensurate with the person's ability.
- d) Add the Individual User to the Authorized User's authorization by [memorandum to the Radiation Safety Officer](#).

2.2.2 INDIVIDUAL USER RESPONSIBILITIES

- a) Use only the types and quantities of radioactive material covered by research Use Authorizations approved by the Radiation Safety Committee.
- b) Adhere to the safety rules and regulations recorded in the Radiation Safety Manual and any communications from the Radiation Safety Committee.
- c) Practice new techniques and procedures before using radioactivity to keep radiation exposures ALARA and to identify possible problem areas that may hamper safety or research outcome.
- d) Inform the Authorized User and [Radiation Safety Officer](#) immediately of radiation related accidents, spills, personal contamination, or loss of radioactive materials, even if these incidents occur after normal working hours.
- e) Wear issued radiation dosimeters, when appropriate. Keep the dosimeters accessible to the Radiation Safety Office. Undertake bioassays, as necessary.
- f) Inform the Authorized User of observed deficiencies or potential problems related to radiation safety. Inform the [Radiation Safety Officer](#) if timely corrective action is not initiated.
- g) Maintain adequate measures for security and control of radioactive material against tampering, loss, theft or unauthorized removal from laboratories or storage areas.
- h) Survey for contamination at required or appropriate intervals after using unsealed radioactive materials.
- i) Assist Authorized User with day-to-day responsibilities, such as keeping complete and accurate records, decontamination of minor spills, labeling use areas and equipment, and keeping other personnel aware of use areas and potential hazards in the lab.

- j) Employ general radiation safety precautions.

2.3 VISITOR USER

A Visitor User seeks to collaborate with an Authorized User on a project usually less than several months utilizing radioactive materials, but is *not* a member of the university community. The sponsoring Authorized User will submit a Visitor User Application (Form RSO7) to the Radiation Safety Committee for approval. The visitor will work directly under the Authorized User and cannot supervise any other users in the lab.

2.3.1 VISITOR USER QUALIFICATIONS

Applicants with Prior Experience. The Authorized User must:

- a) Submit a Visitor User Application form for the prospective Visitor User. Attach documentation of training and Experience (Form RSO1) documenting the person's training and experience.
- b) Provide specific training on laboratory procedures, radiation hazards, rules and regulations, user responsibilities, and emergency procedures. This training must be documented on the [Laboratory Hazard Instruction form](#) (or equivalent) if the person will likely receive a radiation dose of 100 mrem/year or more. Completion of the [Safe Use of Radioactive Materials](#) course is encouraged.
- c) Provide direct (observed) supervision during all use procedures until the Authorized User is confident that the prospective Visitor User can work independently. The period of supervision should be commensurate with the person's experience.

Applicants without Experience. The Authorized User must:

- a) Submit the Visitor User Application (form RSO7).
- b) Provide specific training on laboratory procedures, radiation hazards, rules and regulations, user responsibilities, and emergency procedures. This training must be documented on the [Laboratory Hazard Instruction form](#) (or equivalent) if the person will likely receive a radiation dose of 100 mrem/year or more.
- c) Provide direct (observed) supervision during all use procedures until the Authorized User is confident that the prospective Visitor User can work independently. The period of supervision should be commensurate with the person's background and ability.
- d) Attendance of the [Safe Use of Radioactive Materials](#) course is required.

2.3.2 VISITOR USER RESPONSIBILITIES

- a) Use radioactive materials only as directed by the Authorized User.
- b) Employ all general safety precautions.

- c) Use only equipment and materials for which specific instruction and permission has been given.
- d) Properly wear dosimeter. Return dosimetry, if issued, to the [Radiation Safety Officer](#) at the termination of the project.

2.4 SUPERVISED USER

A Supervised User is a member of the university who has no previous training or experience using radioactive materials; therefore, the Supervised User must always be directly observed and supervised by an Authorized User or experienced Individual User. A Supervised User may be a student who uses radioactive material as part of an academic course or laboratory setting or as an interim process to become an Individual User.

2.4.1 SUPERVISED USER QUALIFICATIONS. The Authorized User:

- a) Will provide specific training before the initial use on laboratory procedures, radiation hazards, rules and regulations, user responsibilities, and emergency procedures. This training must be documented on the [Laboratory Hazard Instruction form](#) (or equivalent).
- b) Will ensure all use is directly observed and supervised personally or by an Individual User familiar with the project.
- c) Must provide the names of Supervised User to the Radiation Safety Officer either individually or by class roster.

2.4.2 SUPERVISED USER RESPONSIBILITIES

- a) Use radioactive materials only under the direction and observation of the Authorized User.
- b) Employ all general safety precautions.
- c) Use only equipment or materials for which specific instruction and permission has been given.
- d) Return dosimetry, if issued, to the [Radiation Safety Officer](#) at the termination of the project.

2.5 TRAINING FOR NON-USERS

People who enter radiation use areas, but are not approved to use radioactive materials (such as students, maintenance or custodial personnel, Deans, Vice-Presidents, and other members of the general public) must receive instruction in accordance with [OAC 3701:1-38-13](#) if they will likely receive from lab sources a total effective dose equivalent (TEDE) of 100 mrem (1 mSv) in a year. The radiation safety program includes training for Environmental Health and Safety staff, animal caretakers, custodians, and maintenance workers. The [Laboratory Hazard Instruction form](#) provides acceptable criteria and documentation to fulfill this requirement.

2.6 EXPERIMENTAL USE AUTHORIZATIONS

2.6.1 USE AUTHORIZATION APPLICATIONS

A Use Authorization is a written communication between an Authorized User and the Radiation Safety Committee that presents how the radioactive material will be used and describes the safety measures that will be taken. The Application to Use Radioactive Materials (Form RSO3) must be reviewed by the Radiation Safety Officer and approved by the Radiation Safety Committee **prior to purchasing or using** the materials. Interim approval may be granted by the Radiation Safety Officer for Use Authorization applications that are clearly compliant with this section of the manual. The Radiation Safety Officer will discuss with the Chair of the Radiation Safety Committee any problems or questionable areas regarding interim approval. The Use Authorization application must show that anticipated radiation exposures or any release of radioactive material is consistent with ALARA. If animals will be used in the study, see the Animal Use section. Each Use Authorization is terminated on the anniversary date of the fifth year of the Radiation Safety Committee's approval date.

The Radiation Safety Committee will review the Use Authorization, specifically considering the adequacy of facilities and equipment to be used; operating, handling, and emergency procedures; and training and experience of proposed users. The submitted Use Authorization for use of radioactive materials will address the following topics. Consult with the [Radiation Safety Officer](#) (775-2169) if you have questions regarding the Use Authorization application.

- a) *list all isotopes* needed to complete the study, *compounds* to be used, and the *total activity* required for each isotope. The compound may be specific (e.g., ^{32}P -[dATP, dCTP]) if the study is limited to those materials; or general (e.g., nucleotides) if the study will use many similar materials. The activity indicated is the most that may be present in the lab at any one time, including that in use, storage, and waste.
- b) *list the personnel involved*, include forms (Form RSO1) for Individual Users who have previous training and experience and ensure all complete the [Safe Use of Radioactive Materials](#) training.
- c) *list intended use and storage areas*.
- d) *address specific safety issues*, such as dosimetry, bioassays, personnel protective measures and equipment, contamination prevention and monitoring, and ventilation requirements.
- e) *briefly describe the investigation*, including procedures and precautions pertinent to use, disposal, and disposition of radioactive materials. Consider:
 - (1) Estimate the activity that will be used each day the experiment is run.
 - (2) Estimate the activity that will be picked up by the Radiation Safety Office or discharged into the sewer.
 - (3) Do you plan to use animals? For ^{14}C or ^3H , will the activity in animal carcasses exceed 0.05 μCi /gram of animal tissue?
 - (4) Indicate the brand of scintillation fluid you will use.
 - (5) Is there a potential for an airborne hazard or contamination of a vacuum system?
 - (6) Will you generate mixed waste?

2.6.2 *USE AUTHORIZATION CHANGE*

- a) Minor Changes. Examples of minor changes include adding or deleting an Individual User, changing the possession limit of a radionuclide, or adding an isotope or compound to a Use Authorization that does not involve procedural changes. Minor changes require a memorandum from the Authorized User to the Radiation Safety Officer indicating the change and briefly explaining the reason. The Radiation Safety Officer may approve the change, subject to review by the Radiation Safety Committee.
- b) Significant Changes. Changes where the procedures or project scope differ significantly from current approved Use Authorizations require the submission an additional Use Authorization application form (Form RSO3). The Radiation Safety Officer may provisionally approve the change, pending final approval by the Radiation Safety Committee.
- c) Use Authorization Renewal. Annually, Authorized Users must review their Use Authorizations to ensure the information is current and accurate. Authorized Users are encouraged to compare their current laboratory procedures, materials used, and personnel against Radiation Safety Office records. The Radiation Safety Officer summarizes the Use Authorization information to facilitate the review.

2.6.3 *USE AUTHORIZATION SUSPENSION*

Authorized Users who are not currently using radioactive materials, but may do so in the foreseeable future may place their Use Authorization in suspension by informing the Radiation Safety Officer in writing. Radioactive materials will be removed from the lab and the lab decommissioned and released for unrestricted use pending continued usage. The Authorized User must notify the Radiation Safety Officer two weeks before radioactive material usage will be resumed. The Use Authorization will be terminated on the anniversary date of the fifth year of the Radiation Safety Committee's approval date.

2.6.4 *USE AUTHORIZATION TERMINATION*

Authorized Users who plan to discontinue using radioactive materials or end their university affiliation must terminate their appropriate Use Authorizations. The Authorized User must:

- a) inform the Radiation Safety Officer of termination plans,
- b) assure that facilities and equipment are free from contamination,
- c) return all remaining radioactive material and dispose of wastes to the Radiation Safety Office,
- d) return the Radiation Safety Manual, dosimetry, survey meters, radiation protection equipment, and shielding devices to the Radiation Safety Office, and
- e) schedule a final laboratory radiation survey and bioassay where appropriate.

2.7 GENERAL PRECAUTIONS WHEN USING RADIOACTIVE MATERIALS

- o Wear a lab coat, gloves, and safety glasses, as required, while handling unsealed radioactive materials.
- o Monitor the work area and gloves regularly to identify contamination and prevent its spread.
- o Do *not* eat, drink, or apply cosmetics in areas where radioactive materials are handled. WSU prohibits smoking in all buildings.
- o Keep radioactive work separated from other work, preferably by maintaining areas used solely for radioactivity.
- o Use *time, distance, and shielding and contamination control* to keep your dose as low as reasonably achievable (ALARA).
- o Work over a spill tray in a certified ventilated enclosure, especially when using large quantities (> 1 mCi) of radioactive materials or compounds that vaporize easily (e.g., ^3H -water and ^{125}I -sodium iodide).
- o Use the minimum quantity of radioactivity needed to meet the objectives of the experiment.
- o Never handle unsealed radioactive materials with open cuts or breaks to the skin.
- o Use tongs or other remote handling equipment to minimize exposure to extremities.
- o Never pipette by mouth.
- o Properly wear dosimetry, if issued, for all radioactive work.
- o Wash your hands and, if applicable, monitor yourself before leaving the lab.
- o Document radioactive material usage and waste disposal on inventory cards.
- o Label radioactive containers clearly, indicating nuclide, activity, compound, and date.
- o Dispose of radioactive waste according to provisions of the experimental Use Authorization, *never in ordinary trash*.

2.8 EXTERNAL EXPOSURE PROTECTIVE MEASURES

2.8.1 TIME

Radiation dose can be decreased by reducing the amount of time users spend working with high-energy beta (β) and gamma (γ) emitting radionuclides. Users should practice new procedures *without radioactivity* to become familiar with the steps involved and to identify potential problem areas. Never rush while working with radioactive materials. Hurrying through a procedure can lead to a spill or accident that may actually increase dose.

2.8.2 DISTANCE

Radiation intensity decreases inversely with the square of the distance ($1/d^2$) when the source is small compared to the distance. The dose from low-energy beta emitters (e.g., ^3H and ^{14}C) is zero at 10 to 20 cm. For high-energy β and γ emitting radionuclides, remote-handling devices (e.g., tongs or forceps) can reduce radiation dose to hands and fingers when handling containers holding large activities. Practice using tongs without radioactivity to become comfortable working with the tools. Store radioactive materials away from personnel, lab benches, or desks where lab personnel may spend a lot of time.

2.8.3 SHIELDING

Attenuating material placed in the radiation path can effectively reduce external exposure. The amount of shielding needed is determined by the type and energy of radiation, composition and thickness of shielding material, distance from the source, time spent in the work area, and acceptable level of dose reduction. The effectiveness of the shielding should be verified using a survey meter. The exposure rate to an unrestricted area and at the user's position should be reduced to 1 mrem/hr or less for long procedures. The exposure rate in an unrestricted area must not exceed 2 mrem/hr.

Low-energy beta (β) radiation (e.g., ^3H and ^{14}C) has a very short range in material; therefore additional shielding is not necessary. Shield high-energy beta emitters (e.g., ^{32}P) with 3/8-inch or more of a low-atomic-number material, such as plastic. Eyewear, such as goggles will substantially reduce ocular exposures and prevent eye contamination. Gamma emitters must be shielded with high-density materials, such as lead. The Radiation Safety Office will assist in the design of shielding upon request.

2.8.4 PRECAUTIONS WHEN USING ^{32}P IN MILLICURIE AMOUNTS

Handling millicurie quantities of ^{32}P when unshielded can expose an investigator to very large dose rates, especially to extremities. One mCi of ^{32}P in one ml of fluid yields a dose rate of about 2 rem/hour at 15 cm above the mouth of an open vial. This dose rate will increase with increasing activity. The User should be aware of the potential high dose rates and be vigilant toward employing protective measures and ALARA. The bremsstrahlung dose rates are unimportant compared to the unshielded beta dose rates. At 15 cm from a 40-mCi vial, the dose rate from bremsstrahlung may be 0.004 rem/hour, where the dose rate from beta radiation may be 50 - 100 rem/hour.

- a. Extremity dosimetry and an operational survey meter are required. Place the extremity dosimeter under the glove and on the finger most highly exposed. Double gloves are encouraged.
- b. Pipetting must take place behind a 3/8-inch plastic shield to protect the head and torso. Efforts should be made to position the stock vial and final container to minimize travel distance and time. Use a tray to transport petri dishes. Cover the dishes to further reduce personal dose and prevent spillage.

- c. An uncollimated liquid-filled pipette tip or petri dish can contribute to dose to the hands. A significant depth of liquid in the petri dish and covers can partially shield the beta dose.
- d. For multi-millicurie quantities, the pipette should have a 3/8-inch plastic plate attached to the grip to shield the hand. The shield should be large enough to keep the hand and forearm out of the beam of the stock vial. Once pipetting is done, the used tip should go directly into a shielded waste container.
- e. Remove the pipetting hand out from the beam of the stock vial as soon as possible after removing the pipette tip. Remove and replace the stock vial cap using tongs. Replace the cap immediately after pipetting.
- f. Monitor your gloves frequently during use. If contamination is found, remove the gloves immediately and dispose of them properly. Adjust your technique to eliminate the cause. Do not accept routine glove contamination. The dose rate from ^{32}P directly on the skin is about 8800 mrem/hour per $\mu\text{Ci}/\text{cm}^2$. A layer or two of gloves will not decrease that dose rate by much.
- g. Monitor your person, including your gloves, face, lab coat sleeves and front, and shoes and the use area for contamination before leaving the work area. Survey for removable contamination as required.

2.9 INTERNAL EXPOSURE PROTECTIVE MEASURES

Radioactive materials are of most concern when they become internally deposited in the body. Radioactive substances can enter the body by inhalation of airborne contamination, oral intake, or absorption through the skin. By working in a well-ventilated space, wearing personal protective clothing, using good work habits, and effectively controlling radioactive materials, internal exposures should not occur.

2.9.1 PERSONAL PROTECTION

Good, basic laboratory technique is the primary defense against contamination and internal exposure. User attire consists of plastic gloves and a lab coat. Safety goggles must be used when required by the university's Chemical Hygiene Plan. Cover open wounds or cuts to avert this route of entry. Do not eat, drink, smoke, or apply cosmetics in the use area. Monitor or change gloves frequently during experiments using unsealed radioisotopes. When using a high-energy β emitter, monitor gloves, the lab coat, and the use area with a survey meter after the experiment is completed. Surveys of other places (e.g., face, shoes, desk, or phone) may also be necessary if contamination is found. Be sure to wash your hands soon after removing gloves.

2.9.2 PROTECTION FROM AIRBORNE CONTAMINANTS

Procedures that can produce contaminated aerosols, dusts, or gases shall be conducted in a fume hood that has been approved by the Environmental Health and Safety Department within the past 12 months. Vials containing tritiated water or large amounts (i.e., greater than 10 μCi) of an unlabeled radioiodine shall be opened in a certified fume hood. When applicable, traps

and filters should be incorporated in the experimental setup to ensure that environmental releases are ALARA and prevent contamination of vacuum systems.

Radioactive gases or materials with gaseous radioactive daughters must be stored in gas-tight containers situated in a fume hood or an approved area having adequate ventilation.

2.9.3 [ANNUAL LIMIT ON INTAKE \(ALI\)](#)

Proper use of protective measures should prevent any personal contamination or internal exposure to radioactive materials. The annual limit on intake (ALI) is the regulatory limit for radioactive material taken into the body by a user in one year. The ALI is based on the intake of a radionuclide (in μCi) that would result in a committed effective dose equivalent (i.e., cumulative exposure) of 5 rem (0.05 Sv) or a committed dose equivalent (i.e., organ or tissue dose) of 50 rem (0.5 Sv). The [Radionuclide Information](#) site lists the ALI for several licensed radionuclides.

2.10 WORK AREA PROTECTION

Users must take precautions to prevent their work areas from becoming contaminated or spreading the problem should contamination occur. Work surfaces should be covered with plastic-backed absorbent paper to minimize the potential of contaminating bench surfaces. Material usage should be performed over small sections of absorbent paper or a spill tray (lined with absorbent paper) to contain spills as well as reduce the waste volume. Use and storage areas should be concentrated in a remote part of the lab to reduce the transport of materials. Unsealed radioactive liquids should be transported on a spill tray, or otherwise secured against spillage.

Users shall ensure that vacuum systems remain free of contamination by demonstrating that evacuated gases are not contaminated. Radioactive gases must be passed through a liquid trap (or other effective means) before entering a vacuum pump or the university vacuum system. Separate vacuum pumps should be vented into an exhaust hood when the experiment produces radioactive gases or aerosols. The vacuum pump oil should be periodically checked for contamination.

Good housekeeping can mitigate mishaps. Users should maintain clean, orderly labs to promote a safe environment.

Only "hot" sinks (i.e., sinks designated for radioactivity) shall be used to dispose of liquid waste or wash contaminated laboratory equipment. After usage, sinks should be copiously flushed. Do not fill containers for consumption from a hot-sink tap.

2.11 PURCHASING RADIOACTIVE MATERIALS

The acquisition of radioactive material requires approval from the responsible Authorized User and the Radiation Safety Office. The Authorized User must ensure that he/she is permitted to have the material and that possession limits will not be exceeded. Endorsement by the Radiation Safety Office allows the Radiation Safety Officer to check the requested material and amount against the Authorized User's approval and prepare for receipt. Approval from the Radiation Safety Office may be obtained by written authorization, phone, or [e-mail](#).

Purchase order forms must include following information: (a) isotope, (b) activity, (c) chemical compound, (d) the words "RADIOACTIVE MATERIAL", (e) the Authorized User's signature, and (f) the signature of a Radiation Safety representative.

All packages containing radioactive material must be delivered to the Radiation Safety Office (example delivery address: "Radiation Safety Officer, 104 Health Sciences Bldg."), unless alternative methods for receipt have been approved by the Radiation Safety Officer. Users are urged to avoid having deliveries made when the Radiation Safety Office is normally closed (i.e., evenings, weekends and holidays). Coordination with the Radiation Safety Office is required if the delivery of a package is expected outside of normal working hours.

2.12 RECEIPT OF RADIOACTIVE MATERIALS

2.12.1 RECEIPT BY RADIATION SAFETY OFFICE

All packages containing radioactive materials will be delivered unopened, to the Radiation Safety Office. Personnel from the Radiation Safety Office will open and inspect the package, perform required surveys [[OAC 3701:1-38-18](#)], and complete the Radioactive Materials Receipt Form. Following clearance, the Radiation Safety Office will add the material to the University inventory and deliver the package to the appropriate user. Records of receipt must be retained for three years.

2.12.2 PACKAGE RECEIPT PROCEDURES:

- a) Visually inspect the package for any sign of damage or degradation (e.g., wetness not due to precipitation, crushed or severely punctured container).
- b) Wear gloves. For high-energy β or γ emitters, also wear dosimetry.
- c) If the package is labeled (i.e., White I, Yellow II, or Yellow III) or damage is suspected, the following surveys **shall** be done within 3 hours of arrival (or by 10 a.m. if the package arrives before normal working hours).
 - (1) Swipe Survey. Monitor (i.e., swipe) the external surfaces of the package for removable contamination. Swipe an area of 300 cm² with a filter pad, or similar absorbent material, using moderate pressure. Count the swipe using a liquid scintillation counter. For γ emitting radionuclides, swipes can be counted on a gamma-well counter.

Action Level: Swipe survey is 200 dpm or greater

Legal Limits [[49CFR173.443](#)]:

- (a) 22 dpm/cm² (6600 dpm/300 cm²) for β - γ emitters and low toxicity α emitters, such as natural thorium or uranium, ²³⁸U, or ²³²Th.
 - (b) 2.2 dpm/cm² (660 dpm/300 cm²) for other α emitters.
- (2) External Radiation Levels. Monitor the surface of the package and at one meter with a radiation detector. Record readings in mrem/hr (or mSv/hr).

Action Levels/Legal Limits [[49CFR172.403](#)]:

 - (a) White I: <0.5 mrem/hr on the package surface.

- (b) Yellow II: ≤ 50 mrem/hr on the surface or ≤ 1 mrem/hr at one meter.
 - (c) Yellow III: ≤ 200 mrem/hr on the surface or ≤ 10 mrem/hr at one meter.
 - (d) Ensure that the container label and shipping manifest agree with purchase order.
- e) Survey the packaging material (e.g., the cardboard box and styrofoam insert). If negative for contamination, remove or obliterate all markings indicating radioactivity and dispose as normal trash. Styrofoam containers for some companies may be shipped back to the manufacturer if not contaminated.
- f) Notify the Radiation Safety Officer immediately if :
- (1) the package appears damaged;
 - (2) the security seal on the outer package is broken;
 - (3) a labeled package is delivered to the wrong place;
 - (4) the package contents do not agree with the packing slip; or
 - (5) the swipe survey or external radiation levels exceed action levels.

2.13 LOCATIONS OF USE AND STORAGE

2.13.1 LICENSED LOCATIONS

The university's license with Ohio Department of Health applies to all licensed radioactive materials on the main campus, Cox Institute, Buildings 307 and 315 at the Veterans Affairs Medical Center in Dayton, or other places specifically listed on the license. Possession of licensed radioactive material at any other location constitutes a violation of the Ohio Department of Health license.

2.13.2 APPROVED USE LOCATIONS

Radioactive material shall be used or stored only in areas specified in the Authorized User's Use Authorization application (Form RSO3), as approved by the Radiation Safety Committee. The laboratory must be properly equipped for the proposed use, such that assurances for supervision, safety, and security are present. Suitable provisions shall be made to prevent inadvertent exposures to students, staff or the public; releases of radioactive material; and loss, unauthorized removal, or theft of materials. All transfers or shipments of radioactive material must comply with the university transportation policies.

Research laboratories should consolidate use or storage areas for radioactive material to minimize the movement of materials through the lab. Use areas should be reasonably isolated from other projects not using radioactive material and clearly marked with "Caution - Radioactive Material" tape.

The Radiation Safety Officer maintains a list of current and former use locations as required by Ohio Department of Health for decommissioning. This list is updated at least every two years.

2.14 INVENTORY OF RADIOACTIVE MATERIALS

2.14.1 INVENTORY CARDS

The Radiation Safety Office initiates and distributes yellow *Inventory of Radionuclides* cards (Form RSO10) with each unsealed source of radioactive material received. Continued maintenance of these cards with current information on use and disposal is necessary for keeping the university's inventory current and accurate. When all the material is disposed, the user indicates the distribution of the waste and returns the card to the Radiation Safety Office.

2.14.2 CENTRAL INVENTORY

The Radiation Safety Officer maintains a computer inventory of radioactive materials. Semi-annually the Radiation Safety Officer performs an inventory of all radioactive materials to ensure the central inventory is up-to-date and that all sealed sources are accounted.

2.14.3 INTER-LABORATORY TRANSFER OF RADIOACTIVE MATERIALS

Transference of radioactive materials to another Authorized User requires that the recipient be authorized by the Radiation Safety Officer to possess the type and quantity of material being provided. The Radiation Safety Officer must be informed so that the inventory can be updated with the new location and owner. The transfer may involve consigning all (full consignment) or part (partial consignment) of stock materials. The below procedures are guidelines that fulfill the requirement of being able to track the material. Other means may be applied providing that Authorized Users only possess materials for which they are approved, the central inventory is updated, and the new user has a way to document his/her usage and disposal.

When transporting radionuclides between labs, users will take precautions to protect unrestricted areas against contamination. Unsealed materials must be contained in a leak-proof receptacle (e.g., a sealed plastic bag) that would not likely break if accidentally dropped.

a) Procedures for Full Consignment of a Radioisotope:

- (1) Ensure the recipient is approved to possess the material.
- (2) On the *Inventory of Radionuclides* card issued for that material:
 - (a) Mark a single line through the name of the "principal investigator" and write the name of the receiving Authorized User.
 - (b) On the next available "New balance" line, write the "Quantity" (activity) transferred, "Date" of transfer, and "Remarks" indicating the transfer (e.g., Transferred to Dr. X in 459 BS II).
 - (c) Give the material and revised card to the recipient Authorized User.
- (3) Inform the [Radiation Safety Officer](#) of the transfer by phone or e-mail. Send the Radiation Safety Officer a photocopy of the revised card. The Radiation Safety Officer will update the central inventory with the new responsible user and location.

b) Procedures for Partial Consignment of a Radioisotope:

- (1) Ensure the recipient is approved to possess the material.

- (2) On the next available "Transferred" line on the *Inventory of Radionuclides* card, write the "Quantity" (activity) transferred, "Date" of transfer, and "Remarks" indicating the transfer (e.g., Transferred to Dr. X, 459 BS II).
- (3) Make two copies of the card. Line out the former responsible user and add the name of new Authorized User to both copies.
- (4) On the original card, enter the activity remaining on the next "New balance" line.
- (5) Provide one copy of the card to the new Authorized User and one to the Radiation Safety Officer.
- (6) The Radiation Safety Officer will update the central inventory.

2.15 TRANSPORT (SHIPMENT) OF RADIOACTIVE MATERIAL

Packages of radioactive material shipped over public roads must comply with regulations of the [Department of Transportation](#) (49 CFR 172, 173) and [Ohio Department of Health](#) rules. These regulations specify numerous requirements, such as: package labeling, manifests, contamination surveys, exposure rate measurements, and hazardous materials training. To ensure compliance with these requirements, ***only the Radiation Safety Officer or qualified Radiation Safety Office personnel can authorize the shipment of radioactive materials over public roadways.***

When radioactive materials are to be shipped from the university, the Radiation Safety Office will inspect the contents and packing, check for contamination and radiation levels, and ensure all other regulatory requirements are met. The Authorized User must provide the complete name and address of the intended recipient including the delivery address for the receiving Radiation Safety Office or department. A copy of the recipient's NRC or agreement state license ***must be*** obtained ***prior*** to shipping to ensure recipient can possess the material. Transport by private conveyance is prohibited, unless approved by the Radiation Safety Officer.

2.16 SECURITY

The loss or theft of radioactive material can result in a violation of the Ohio Department of Health license and possibly personal injury. Licensed radioactive materials in storage or use must be secured against tampering, loss, unauthorized removal and theft. **The room where materials are used or stored must be locked whenever a user is not present.** Radioactive materials secured in a locked container (e.g., freezer) achieve this requirement when the above measures cannot be met. The University Radiation Safety Committee may require additional security measures or allow alternate security methods, depending on the specific situation. Lab personnel should assist unfamiliar persons who enter the lab and ensure they do not enter an area where they would likely receive a dose of 100 mrem in a year without radiation safety training. Food and beverages must not be stored with licensed radioactive material. Immediately inform the Radiation Safety Officer if radioactive material is discovered missing.

2.17 POSTING / LABELING WARNING SIGNS

Warning signs and labels heighten the awareness of persons who may enter the lab. Labels mark areas and equipment that may be contaminated and provide a constant reminder for laboratory personnel, custodians, and maintenance personnel to exercise caution and responsible action. The Authorized User ensures that labels on equipment, benches, and

containers are appropriate. The Radiation Safety Officer evaluates posting and labeling when auditing laboratory practices.

2.17.1 POSTING AT RADIATION USE AREAS

- a.) Radioactive Materials. A warning sign bearing the radiation symbol and "Caution Radioactive Material" must be conspicuously posted in or at the entryways to labs and store rooms in which radioactive materials in amounts exceeding values on the Radionuclide Information form (*Required Area Posting*) are being used or stored [[OAC 3701:1-38-18](#)]. The name of the individual responsible for the posted area should be displayed at each entryway to facilitate contact in case of emergency. Warning signs must not be removed from any room, except by Radiation Safety personnel following a clearance survey.
- b.) Radiation Area. A warning sign bearing the radiation symbol and "Caution Radiation Area" must be conspicuously posted in or at the entryways to labs and storerooms in which a radiation area is present. A radiation area is an accessible area where the dose rate at 30-cm from the source or shielding exceeds 5 mrem/hr.
- c.) Notice to Employees. Ohio Department of Health form 4786.32, "[Notice to Employees](#)", must be visibly posted in or near laboratories where the radioactive materials are located [[OAC 3701:1-38-10](#)]. Each notice has been amended to include a statement indicating that users may review Ohio Department of Health rules, current licensing documents, or applicable operating procedures by contacting the [Radiation Safety Officer](#).
- d.) Damaged Signs. The Authorized User will notify the Radiation Safety Officer for replacement if any posted form is found to be defaced, altered, or removed.
- e.) Sign Removal. Only a representative of the Radiation Safety Office, following a release survey, may remove a posted radiation sign.

2.17.2 USE AREAS WITHIN LABORATORIES AND EQUIPMENT LABELS

- a.) Use Areas. The borders of use areas (e.g., benches, hot sinks, fume hoods) within the lab shall be conspicuously marked with "Caution-Radioactive Material" labels. Areas with residual contamination must also be marked and covered to prevent the spread of contamination. Laboratory personnel must survey for contamination when a use area is discontinued or moved to another location within a restricted laboratory. The survey documentation must be retained for 3 years.
- b.) Radiation Areas. Radiation areas in the laboratory, i.e., areas where radiation levels are sufficient to expose a continuously present individual to 5 millirem in any hour shall be labeled as a radiation area.
- c.) Equipment. Equipment or appliances (e.g., refrigerators, centrifuges, pipettes) used with or contaminated with radioactive material shall bear a label with the radiation symbol and "Caution-Radioactive Material". Labeled equipment must be surveyed for

contamination prior to disposal, repair, or unrestricted use. The Radiation Safety Office will perform this survey when requested by laboratory personnel.

2.17.3 CONTAINER LABELS

- a) Containers in which materials are held shall bear a durable, clearly visible label bearing the radiation caution symbol and the words "Caution Radioactive Material." The container label shall also indicate sufficient information, such as the following, so that persons working in the area can take precautions to minimize exposures. The information must include: isotope, compound, activity, radiation levels, and date of assay or receipt.
- b) Removing Container Labels. Containers must be surveyed prior to release. All radioactive material markings must be removed or defaced from *uncontaminated, empty* containers before disposal or release for unrestricted use.
- c) Exemptions to Containers Labeling.
 - (1) Containers holding material in amounts less than indicated on the [Radionuclide Information](#) form, *Container Labeling*.
 - (2) Containers attended by an individual who takes precautions to prevent exposure to others (e.g., beakers, flasks, and test tubes that are used transiently in laboratory procedures and subsequently cleaned in a hot sink).

2.17.4 SIGN / LABEL ACQUISITION

Radiation warning signs are available from the [Department of Environmental Health and Safety](#). Labeling tape may be obtained from Laboratory Stores or commercial vendors.

2.18 SURVEYS FOR CONTAMINATION

Surveys for radioactive contamination are necessary to demonstrate either that no contamination is present or to identify contaminated surfaces so that they may be cleaned before contamination spreads. Users shall perform sufficient surveys to identify any contamination resulting from their usage. The [Radionuclide Information](#) form shows recommended methods of laboratory monitoring for commonly used isotopes. Two methods of contamination monitoring are surveying for removable contamination (also called swipes or wipes) and using an operational survey meter for monitoring accessible surfaces.

2.18.1 SURVEYS FOR REMOVABLE CONTAMINATION (SWIPES)

- a) Swipe Frequency. Use and adjacent work areas must be surveyed for removable contamination:
 - (1) **Monthly**, if the activity used in a day is **200 μ Ci or less**. The Radiation Safety Office routinely performs these surveys.
 - (2) **Weekly**, if the activity used in a day is **more than 200 μ Ci**. These surveys must be performed within one week after the high usage. The user is responsible for

ensuring these surveys are completed. The Radiation Safety Office will perform this survey on request.

- (3) **By the end of the day**, if **1 mCi or more** of ^{125}I is used (see Iodinations). When using more than 1 mCi of other beta or gamma emitters, users are encouraged to perform swipe surveys immediately following usage. The Radiation Safety Office will perform these surveys on request. After use of ^{32}P (or other high energy beta or gamma unsealed sources), a complete survey of the user and the work area with an operational survey meter must be performed.

- (4) **Immediately**, if contamination is suspected.

b) Recommended Swipe Procedures.

- (1) Put on a plastic glove on the swiping hand. This requirement may be waived in non-use areas where contamination is not expected.
- (2) Use a wet or dry swipe pad (filter paper is acceptable). Wet pads collect contamination more efficiently, but are harder to work with than dry pads.
- (3) Applying moderate pressure, press the pad on the surface to be monitored. The area surveyed should cover 100 cm^2 ($\approx 4" \times 4"$). If no contamination is expected, the survey area can be expanded.
- (4a) *Liquid Scintillation Counting (for α , β , and low-energy γ emitters).*
Place the swipe pads in individual scintillation vials and add scintillation cocktail. In one vial add a blank pad, which represents the background level. Count the vials using a program that includes the energy of the isotope used.
- (4b) *Gamma Well Counting (for γ emitters only)*
Place the swipe pads in individual counting tubes. In one tube add a blank pad, which represents the background level. In another tube, add a reference source (e.g., ^{125}I -Sim, ^{137}Cs - depending on the energy of the suspected contaminant). Count the tubes using a program that includes the energy of the reference source and the isotope used.

c) Swipe Result Documentation. The print out from the counter may be used as documentation for the survey or the survey data may be transcribed to another sheet. The record must contain the following information and be **retained for 3 years** for review by inspecting personnel. A diagram of the lab is helpful to correlate the survey results to physical locations in the lab. The record should include the:

- (1) date
- (2) room number,
- (3) make and model of the instrument used to count the swipes,
- (4) cpm (and dpm, if the efficiency or quench curve is established),
- (5) a means of tracking the swipe results to specific locations in the lab (i.e., descriptively (e.g., floor near fume hood) or diagrammatically (e.g., correlate the value to a diagram of the lab)), and
- (6) signature or initials of the person performing the survey.

d) Swipe Action Levels.

- (1) *Restricted Areas.* Work areas and equipment should be kept as free of contamination as practical. The action level for decontamination of β or γ emitters

is **200 dpm per 100 cm² or three times background**. The action level for decontamination of α emitters is 20 dpm per 100 cm².

- (2) *Unrestricted Areas*. In unrestricted areas or areas that are to be released for unrestricted use, no contamination should be evident. This condition is met if the measured values cannot be distinguished from background level (i.e., are less than the minimum detectable level (MDL) for the detecting system). The following equation may be used for determining the MDL, where R_b is the background count rate (cpm) and t_s is the sample counting time (minutes, providing the counting times for the background and sample are the same).

$$MDL = \frac{3 + 3.29\sqrt{2 R_b t_s}}{t_s}$$

An acceptable level exists when the sample count rate minus the background count rate is less than the MDL. The Radiation Safety Officer will evaluate values that exceed the MDL on a case-by-case basis.

2.18.2 SURVEY METER MONITORING

Laboratories that use over 200 μ Ci of high-energy β or γ emitters must be equipped with a portable survey meter for personnel and area monitoring. Gloves and the use area should be monitored frequently during operations using radioactivity. After the procedure is completed, the user should monitor all potentially contaminated surfaces (e.g., the use area, gloves, lab coat, shoes, adjacent areas). This survey is required when using 1 mCi or more of high-energy beta or gamma emitters. If the survey is negative, the gloves should be disposed and hands washed prior to leaving the laboratory.

- a) Meter Appropriation. Investigators involved in research are encouraged to acquire their own instruments for routine use from the funding for their research. The Radiation Safety Office will provide consultation on the selection of instruments for purchase. For special applications, survey meters may be loaned from the Radiation Safety Office.
- b) Calibration / Repair. The Radiation Safety Office provides annual calibration for most survey meters. The cost of repair or replacement of instruments damaged through misuse or careless handling is the responsibility of the laboratory.
- c) Operational Checks. Prior to use, the survey meter should be checked to ensure it is operating properly. Never use a survey meter that is not fully operational. Check the:
 - (1) *Battery condition*. If low, change the batteries or consult the Radiation Safety Officer.
 - (2) *Calibration label*. The instrument should be calibrated within 1 year.
 - (3) *Meter response* with a check source on the side or stock vial.
- d) Monitoring Procedures. Use the open window part of the probe for maximum detectability. Move the detector slowly about $\frac{1}{4}$ inch from the surface. Using the audio (if available) facilitates detection at background levels. Sporadic counts may be due to cable movement. Areas where this occurs should be monitored again with the detector

movement suspended until the reading can be made. Questionable areas should be cleaned or wiped. Most meters read in either "mR/hr" or "cpm" or both.

- e) **Survey Action Levels.** Any unlabeled area that clearly reads above background should be cleaned and resurveyed. Decontamination must be initiated if measured levels exceed 100 cpm or 0.1 mR/hr above background. If the contamination cannot be removed, notify the Authorized User and the [Radiation Safety Officer](#). Also, the Authorized User and Radiation Safety Officer must be notified of any personal contamination.

2.18.3 RELEASING EQUIPMENT FOR REPAIR OR UNRESTRICTED USE

Labeled or potentially contaminated equipment may not be removed from a restricted area to an unrestricted area for any purpose (including repair, maintenance, disposal, or resale) until it is determined to be free of contamination by Radiation Safety personnel, who will document the release in writing. A copy of the release documentation should accompany the equipment to its destination. All radiation-warning labels must be removed from the equipment before it leaves the restricted area.

If the survey reveals evidence of contamination, the equipment will not be released until it has been decontaminated. Authorized Users are responsible for cleaning their equipment. The [Radiation Safety Office](#) will assist decontamination efforts upon request. Notify the Radiation Safety Officer if contamination cannot be removed. If repair of contaminated equipment is necessary, Radiation Safety personnel or an approved user will monitor the work to ensure that necessary precautions are observed.

2.18.4 RELEASING LABORATORIES FOR UNRESTRICTED USE

Any restricted laboratory or storage room requires a survey for contamination prior to releasing the area for unrestricted use. Radiation Safety personnel will survey all areas and equipment marked with "Radioactive Material" warning labels. The survey will randomly include other areas (counters, floors, equipment, desks, sink basins, and traps) for assurance. Potential storage areas (e.g., cabinets, drawers, refrigerators, and freezers) will be visually inspected for any item bearing a radiation-warning label. Once the lab is found to be free of radioactivity and contamination, all warning signs are removed and the Authorized User (or Department Chair if the Authorized User has left the university) is informed of the results in writing.

2.19 RADIOACTIVE SPILLS / EMERGENCY RESPONSE

2.19.1 RESPONSE TO MINOR SPILLS OF LIQUIDS AND SOLIDS (< 1 mCi)

- a) Warn people in the area that a spill has occurred. Restrict uninvolved people from entering the area.
- b) Prevent the spread of contamination by covering the spill with absorbent paper. Establish a boundary to the spill site. **[Note:** If the material evaporates quickly (e.g., a toluene solvent), turn on a nearby fume hood and vacate the area. Notify the Radiation Safety Officer as soon as possible.]

- c) Wearing protective clothing (gloves, lab coat, eye protection, and shoe covers), clean up the spill with absorbent paper, soap and water, or a commercial decontamination agent. Place contaminated materials in radioactive trash.
- d) Survey the area. Check the hands, clothing, and shoes of potentially contaminated persons for contamination.
- e) Report the spill to the Authorized User and Radiation Safety Officer (Emergency Contact Phone Numbers). The Radiation Safety Officer will complete the Radioactive Spill Report.
- f) Continue decontamination as needed.
- g) Place all contaminated materials into properly labeled radioactive waste containers.

2.19.2 RESPONSE TO MAJOR SPILLS OF LIQUIDS AND SOLIDS (> 1 mCi)

- a) Clear the area. Inform all persons not involved in the spill to leave the room.
- b) Prevent the spread of contamination by covering the spill with absorbent paper, but do not clean it up. Prevent the spread of contamination by limiting the movement of persons who may be contaminated.
- c) Close the room and lock (or otherwise secure) the area to prevent entry.
- d) Immediately, notify the Radiation Safety Officer and Authorized User. The Radiation Safety Officer will supervise the clean up and complete the Radioactive Spill Report.
- e) Remove contaminated clothing and decontaminate affected persons.

2.19.3 FACILITY DECONTAMINATION

Users, under the direction of the Authorized User, are generally responsible for decontaminating laboratory equipment or spaces. The level of contamination should be assessed and preparations for decontamination should begin as soon as possible. Soap and water or commercial decontamination agents are able to reduce the contamination to acceptable levels in most cases. Should the contamination persist or the activity spilled be 1000s of dpm, obtain assistance from the Radiation Safety Office.

2.19.4 PERSONAL DECONTAMINATION

- a) Skin Decontamination. If contamination is found on the skin, **immediately** wash the contaminated area of the body for 2 to 3 minutes in warm water with a mild soap or a commercial cleaning agent *specifically designed for skin decontamination*. Avoid prolonged or coarse scrubbing that irritates the skin, which can increase absorption and inhibit further decontamination efforts. Notify the Authorized User and [Radiation Safety Officer](#) immediately after the decontamination effort. The Radiation Safety Officer may attempt more advanced decontamination techniques or perform a bioassay, if indicated.
- b) Wound Decontamination. If an incident occurs where the skin is broken and contamination is evident, contamination of the wound should be suspected. Immediately notify the Authorized User and the [Radiation Safety Officer](#). Cover the wound with gauze or a bandage, and cleanse the adjacent skin with soap and tepid water. Uncover the wound and wash the injured site with soap and tepid water. Monitor the wound and skin for residual contamination. If medical care is needed, see Medical Emergencies.

- c) Internal Decontamination. Immediately notify the [Radiation Safety Officer](#) if internal contamination is suspected. Body surveys and bioassays (e.g., urine or fecal sampling) may be necessary. The treatment for internal contamination depends on the radioisotope and its chemical nature. Some dose reduction methods may involve administration of agents that reduce absorption, a large intake of fluids, or induction of vomiting. If medical care is needed, see Medical Emergencies.
- d) Clothing Decontamination. Contaminated clothing must be removed as soon as a temporary change of clothes is available. The Radiation Safety Office will take possession of contaminated clothes and will return them to the owner either after decay or successful decontamination and monitoring. **Do not** use the university laundering facility for washing contaminated clothes or lab coats.
- e) Report of Contamination. A report of contamination will be completed by the Radiation Safety Office, with input from involved parties, and forwarded to the Radiation Safety Committee for review. The report will include the circumstances leading to the incident, the chemical form, activity and method of assay of the radionuclide, how the accident occurred, and subsequent actions.

2.19.5 MEDICAL EMERGENCIES

Situations involving personal injuries may vary significantly. The outcome of an emergency depends largely on the discretion of those persons present. The following list of priorities prescribes general guidance for emergency actions. Don't Panic. The university procedures for injuries and illnesses are outlined in [Wright Way Policy 6031](#). *Inform health care providers when contamination may be present so that they may utilize proper protective measures.*

- a) **Remove the injured persons from imminent hazards (e.g., fire) and render first aid to save the victim's life or stabilize the injury.** A person without life-threatening injuries, such as a broken arm, may be decontaminated before seeking medical assistance. Call the [Radiation Safety Officer](#) immediately.
- b) **Report the injury (and hazardous condition, if one exists) to the Public Safety Communications Center** (dial 911 or ext. 2111 or use an emergency telephone located in the corridors throughout campus). For off-campus laboratories, use medical facilities immediately available (e.g., Kettering Hospital or the VA Medical Center). If these facilities are not immediately available, call the local paramedics for assistance. The injured party should always be accompanied by a university employee whenever possible. Do NOT delay treatment for radioactive decontamination, unless the injury is not critical.
- c) **Notify the Radiation Safety Officer and Authorized User** (Emergency Telephone Numbers). Brief the Radiation Safety Officer, upon his arrival, on the events that occurred, personnel involved and injured, and their disposition.
- d) **Protect yourself from contamination** by wearing protective covering (e.g., gloves, boots, and lab coat).

- e) Take steps to **prevent or minimize the spread of contamination** and make the patient comfortable. Restrict the entry of unnecessary persons into potentially contaminated areas. Detain potentially contaminated persons in a safe location.
- f) **Do not attempt to fight a fire** unless it can be easily controlled and you are trained in the use of fire extinguishers. Avoid inhalation of smoke, fumes, and dust.

2.20 BIOASSAYS FOR INTERNAL EXPOSURE

Bioassays for measuring internal radiation exposure are performed whenever an intake of radioactive material is suspected, when a user may exceed 10% of the Annual Limit on Intake (ALI), a minor or declared pregnant woman may intake a committed effective dose of 50 mrem (0.5 mGy), or at the discretion of the Radiation Safety Officer.

- a) Thyroid Bioassay. Approximately 30% of radioiodine taken in the body deposits in the thyroid gland. Thyroid bioassays are required before the first iodination procedure and after each procedure thereafter. This exam monitors the thyroid gland using a sodium iodide (NaI) detector. Post-iodination bioassays are performed between 24 and 72 hours after the procedure. An immediate bioassay should be performed if an intake of iodine is suspected, so that a thyroid-blocking agent can be administered, if necessary. *Any person who refuses to have a thyroid bioassay performed will not be allowed to take part in an iodination procedure.*
- b) Bodily Waste Analysis. After an intake of radioactive materials has occurred, some of the unabsorbed materials are eliminated as waste and can be measured in the person's urine or feces, depending on the radioisotope. A urine sample is a relatively simple procedure that can determine intake. Any refusal to submit a sample for analysis must be documented.
- c) Nasal and Throat Swabs. Swabs of the nasal opening and throat can indicate that an acute inhalation exposure has occurred. These samples may be taken by the Radiation Safety Officer following a suspected inhalation incident. Any refusal to submit to this procedure must be documented.

2.21 IODINATION PROCEDURES

RADIOIMMUNOASSAY (RIA) KITS

Radioimmunoassay (RIA) kits have compounds labeled with ^{125}I and activities less than 10 μCi . A fume hood, survey meters, and bioassays are not usually required for using RIA materials. When using materials in any form labeled with radioactive iodine in amounts greater than 10 μCi , additional protective measures may be warranted.

2.21.1 IODINATION PROCEDURES

An iodination process uses an unlabeled radioiodine to label a compound. This process typically utilizes millicurie quantities of ^{125}I and poses a genuine potential for exceeding the university release limits, contaminating laboratory personnel and spaces, or incurring an intake of radioactivity. For these reasons, the following requirements for iodinations apply:

- a) Inform the [Radiation Safety Officer](#) at least 2 days in advance of each iodination procedure.
- b) A thyroid bioassay must be performed on each participant *before* the first iodination. *After each* iodination thereafter, a follow-up thyroid bioassay must be performed between 24 and 72 hours of completion.
- c) Inform the [Radiation Safety Officer](#) *immediately* if inhalation or personal contamination is suspected. If an intake is confirmed a potassium iodide blocking agent must be administered as soon as possible to mitigate exposure to the thyroid. The recommended KI dose is 1.4 mg/kg body mass [ref: Ribela, M.I., Health Physics, 76 (1): 11-16, 1999]. KI when given within 4 hours of exposure provides about 68% blocking effectiveness.
- d) Prepare an "iodine trap" solution of 0.1 M each of sodium thiosulfate, sodium iodide, and sodium hydroxide if the iodination procedure is performed outside of the iodination glove box. This solution will trap free iodine for decontamination and disposal purposes.
- e) The work must be performed in a fume hood, vented to the outside, with a minimal flow rate of 100 ft/min. The flow rate must have been certified within the past 12 months. Ensure the fan is on during the procedure. Keep the sash at a low, but comfortable position to maximize negative draw.
- f) An iodination glove box with charcoal absorbers must be used to mitigate the release of ¹²⁵I to the atmosphere. Ensure the fan works properly during the entire procedure.
- g) A calibrated survey meter with a low-energy gamma detector is required. Frequent monitoring of gloves and around the fume hood should be performed to quickly identify contamination.
- h) First practice the iodination procedures without radioactivity to become familiar with the steps involved and identify ways to reduce the potential of exposure.
- i) Wear two pair of gloves to prevent absorption through the skin. Change the outer pair immediately if contaminated.
- j) The Radiation Safety Officer may monitor the vented exhaust from the fume hood and the breathing zone of the person performing the iodination to ensure no limits are exceeded.
- k) Keep contaminated trash in the fume hood as long as possible. Double bag the waste for pick-up by EHS.
- l) Monitor gloves, exposed clothing, lab coat, and the work area (including the floor) for contamination after completion of work. Monitor and wash hands before leaving the lab.
- m) Survey the use area for removable contamination following the iodination procedure.
- n) Notify the [Radiation Safety Officer](#) if personal or laboratory contamination is suspected.

2.22 SEALED RADIOACTIVE SOURCES

2.22.1 LEAK TESTS OF SEALED SOURCES

Sealed sources must be leak tested by the Radiation Safety Office upon receipt and every three or six months. The method of testing must be able to detect the presence of 0.005 μCi , which is the Ohio Department of Health action level. Should this level be met or exceeded, the source will be removed from service for decontamination, repair, or disposal. The event must be reported to the Ohio Department of Health within 5 days. The radioactive material license lists the categories of sources that are exempted from the leak testing requirement.

When a non-exempt sealed source is removed from storage, it shall be leak tested before use or transfer. Stored sealed sources shall be leak tested at least every 5 years.

2.22.2 GAS CHROMATOGRAPHY EQUIPMENT

Electron capture detectors available on some gas chromatography units contain radioactive foils used to ionize the carrier gas. The foil, which contains 15 mCi or less of ^{63}Ni , is contained in a detector cell. The carrier gas enters the bottom of the cell, passes by the radioactive foil, and exhausts at the top. The exhaust must be vented to the outside. An effluent trap may be used to capture exhaust vapors, if approved by the Radiation Safety Officer.

The radioactive source shall not be removed from the electron capture device. In order to ensure the integrity of the detector foil, adhere to the manufacturer's guidelines for use. The detector can only be cleaned under the direction of the Authorized User using procedures established by the manufacturer. Inform the [Radiation Safety Officer](#) each time that this procedure will be performed so that the source may be leak tested after the cleaning process.

If damage to the detector is suspected, immediately notify the Authorized User and the Radiation Safety Officer. A test for source leakage and radioactive contamination should be performed before removing a potentially damaged source. A contaminated electron capture device must be handled with caution to prevent the spread of contamination. After the detector has cooled, remove it with gloved hands. Wrap the gloves around the electron capture device after removal to contain any contaminants.

2.23 ANIMAL USAGE INVOLVING RADIOACTIVE MATERIALS

If facilities of the Laboratory Animal Resources department are to be used for housing, care, or feeding of animals contaminated with radioactive material, Form LAR/RS14, "Animal Care Information", must be completed and signed. It is submitted with the Use Authorization application, Form RSO3, to the University Radiation Safety Committee and Director of Laboratory Animal Resources for approval. Handling and disposal should be clearly addressed on the Use Authorization application, Form RSO3. Experimental animals shall not be used for human consumption.

The Authorized User must ensure that the presence of radioactivity and specific instructions are fully communicated to lab animal staff by ensuring the following requirements are met.

- a) Posting. The entryway to a room holding contaminated animals shall be posted with a "Caution: Radioactive Materials" sign.

- b) Instructions. Instructions for caretakers must be posted on or near the animal cages. A Lab Animal Information Notice fulfills this requirement when completed and signed. The instructions should address relevant information regarding personal protection, dosimetry, feeding, changing bedding, disposition of dead or ill animals, and any special directions required for experimental control.
- c) Labeling. Cages housing contaminated animals, waste containers, and any potential contaminated equipment must be properly labeled with "Caution: Radioactive Material" tape. The labels on cages and waste should indicate the isotope, date (or beginning date) of administration, estimated activity of radioactive material, and the Authorized User.
- d) Containment. Radioactive animal waste must be contained by using under pads, collecting urine, or other means, as appropriate.
- e) Survey/Decontamination/Cleaning. The warning labels on potentially contaminated cages should be removed just before being washed. The Radiation Safety Office will survey potentially contaminated equipment upon request.
- f) Transport. Movement of contaminated animals through uncontrolled areas of the University is discouraged. If necessary, Form Radiation Safety Officer 3 will specify precautions to be taken to prevent contamination of uncontrolled areas and unnecessary exposure of anyone in these areas.

2.24 RADIOACTIVE WASTE

Safe disposition of radioactive waste materials comprises an essential component of the Radiation Safety Program and regulatory compliance. The Authorized User is responsible for ensuring that radioactive waste is properly contained, labeled, and disposed. Each proposed Use Authorization application must address the types of radioactive waste expected to be generated and the disposal methods. Contact the [Radiation Safety Office](#) (775-2169) if you have any questions regarding disposal of any specific waste.

2.24.1 CONTAINMENT AND LABELING OF WASTE

Radioactive waste bears the same precautions as the radioactive materials. The materials must be properly contained to prevent spills or breakage. The type of container is specific to the type of material. Correct labeling of the waste container is essential to ensure that the contents are identified and that the material is not mistakenly discarded as regular trash. Materials that comprise of high-energy β or γ emitters should be shielded to reduce exposure to laboratory personnel.

2.24.2 DISPOSAL RECORDS

Documentation of waste disposal is mandatory for regulatory compliance. Waste disposal records must be retained indefinitely. Authorized Users must ensure that the distribution of disposed radioactive waste is accurately communicated to the Radiation Safety Office. The most effective means of accomplishing this is recording distribution information on the Inventory

Card. The Inventory Card is returned to the Radiation Safety Office when the radioactive material is expended.

- a) Documentation on the Inventory Card. As radioactive waste is disposed, the means of disposal should be summarized on the *Inventory of Radionuclides* (Yellow) Card (Form Radiation Safety Officer 10). The summary should identify the waste method (e.g., drain or sink, solid, liquid, organic scintillation, mixed waste) and estimated activity or percentage of activity for each disposal route.
- b) Labeling. All waste containers submitted to the Radiation Safety Office for disposal must be tagged with a label appropriate for the waste contents. When properly completed, these labels provide the information needed for proper disposition. Labels for solid, liquid, scintillation vial, and animal wastes are available from the Radiation Safety Office. For waste contaminated with short half-life material (<120 days) and with consideration for ALARA, remove or deface radiation labels before discarding the waste into radioactive trash. This will help the Radiation Safety Office with the disposal process.

2.24.3 WASTE MINIMIZATION

The high cost of radioactive waste disposal and the spirit of efficient utilization of resources require practical and cautious means of reducing waste volume, primarily by minimizing waste generation. Some methods are:

- a) substituting non-radioactive compounds or radioisotopes with half-lives less than 120 days where practicable.
- b) carefully segregating radioactive waste from non-radioactive waste.
- c) separating short-lived radioactive waste (i.e., half-life less than 90 days) from long-lived radioactive waste (i.e., half-life greater than 120 days).
- d) avoiding unnecessary contamination of items during the use of radioactive materials.
- e) purchasing the minimum amount of radioactivity needed for experimental purpose.
- f) decontaminating materials.
- g) avoiding generation of mixed waste.

2.24.4 SOLID WASTE

Solid, non-reusable waste, such as contaminated absorbent paper, gloves, empty containers, must be placed in the plastic bag-lined poly bucket, supplied by the Radiation Safety Office. Consider double bagging waste that contains millicurie levels of radioactivity. **IMPORTANT:** Do *NOT* place sharp objects such as syringe needles or razor blades in waste bags. Doing so could result in injury and contamination of personnel. Always discard needles in a properly labeled sharps container that is not used for chemical or biological waste purposes.

Solid, breakable, non-reusable waste, such as contaminated glass pipettes and beakers must be placed in an appropriate container, such as a poly-lined box. The added support will prevent personal injury or internal contamination should the material break.

- a) Pick-up. When the container is sealed and properly labeled, call or [e-mail](#) the Radiation Safety Office (775-2623/2169) to remove the waste.

- b) Disposal. The Radiation Safety Office will dispose of the material according to its half-life. Materials with a half-life less than 120 days are held for decay-in-storage and materials with half-lives greater than 120 days are disposed as low-level radioactive waste.

2.24.5 LIQUID WASTE

The disposal method for liquid radioactive waste depends on its solubility in water and its EPA hazard class. Liquid waste intended for pick-up by [Radiation Safety Office](#) personnel must be placed in a sealed, non-leaking container (e.g., capped plastic or glass bottle) and tagged with a properly completed Liquid Waste label available from the Radiation Safety Office.

- a) Liquid Waste Soluble in Water. Liquid radioactive waste that is soluble in water may be disposed into the sewer system providing the following conditions are met. Short-lived material (i.e., half-life less than 120 days) can be held for decay to minimize the activity released.
 - (1) The liquid must be readily soluble in water. Compounds described in the Handbook of Chemistry and Physics as Very Soluble (VS) or Soluble (S) fulfill this requirement. NOTE: Readily dispersible biological material is also allowable with approval from the Radiation Safety Officer.
 - (2) The sink used must be designated as a "Hot Sink" and labeled as such.
 - (3) The liquid must not be a hazardous waste that would violate disposal regulations of the EPA. Contact the [Hazardous Waste Manager](#) (775-3118/2215) if the waste may fall into this category.
 - (4) Monthly disposal limit per lab. Contact the Radiation Safety Officer if you may exceed these values:
 - Tritium (^3H): 1000 μCi (1 mCi, 37 MBq)
 - Carbon-14 (^{14}C): 500 μCi (0.5 mCi, 18.5 MBq)
 - All other radionuclides combined: 500 μCi (0.5 mCi, 18.5 MBq)
- b) Liquid Waste **NOT** Soluble in Water. Liquid radioactive waste that is *NOT* soluble in water must be picked up by the Radiation Safety Office for disposal.

2.24.6 LIQUID SCINTILLATION VIALS

The disposal method for liquid scintillation vials depends on the type of scintillation fluid and the concentration of activity. Scintillation vials must be securely capped to prevent leakage. Vials disposed through the Radiation Safety Office should be in a vial tray (or otherwise stored upright in a box) that is properly labeled.

- a) Biodegradable Liquid Scintillation Fluid. Before disposing of a scintillation fluid marketed as biodegradable down a sink as liquid waste, verify the material is suitable for sewer disposal by contacting the [Radiation Safety Officer](#) or [Environmental Compliance Officer](#) (775-2169/3788). Once clearance is obtained, sink disposal is acceptable providing no solids or insoluble materials are released into the sink. The empty vials should be rinsed out two or more times before disposal in regular trash.
- b) Organic Liquid Scintillation Fluid. Organic or non-biodegradable scintillation fluid must be picked up by the Radiation Safety Office for disposal.

- c) Exempted Levels of Activity. Liquid scintillation vials containing ^3H or ^{14}C with activities less than 0.05 μCi per gram of scintillation fluid may be disposed as if they were not radioactive. Any vials that are to be picked-up by the Radiation Safety Office must be properly labeled regardless of exempted status.

2.24.7 DECAY-IN-STORAGE

- a) The university may hold materials with half-lives of less than 120 days for decay-in-storage. The material must be held for 10 half-lives. A survey must be performed to verify that the material cannot be discerned from background. All radiation labels must be removed or obliterated prior to disposal as normal trash.
- b) Records of Disposal. A record of each disposal must be held for at least 3 years. The record must include the:
 - (1) disposal date,
 - (2) radionuclides disposed,
 - (3) survey instrument used,
 - (4) background dose rate,
 - (5) dose rate measured at the surface of each container, and
 - (6) name of the person who performed the disposal.

2.24.8 ANIMAL WASTE

- a) Containment. Animal carcasses, excrement, and associated wastes containing radioactivity will be wrapped in absorbent paper, placed in a plastic bag, and refrigerated or frozen. Double bagging and packaging in a box or can is encouraged when one bag may not hold the waste. Contact the [Radiation Safety Office](#) for disposal.
- b) Labeling. The container of contaminated animal matter must be tagged with an Animal Waste label available from the Radiation Safety Office.
- c) Exempted Levels of Activity. Animal waste containing ^3H or ^{14}C with activities less than 0.05 μCi per gram of animal tissue averaged over the entire animal may be disposed as if the material were not radioactive. Waste meeting these criteria should be addressed in the user's Use Authorization or in supplementary documentation.

2.24.9 MIXED WASTE

Mixed waste is radioactive waste that also contains other hazardous materials regulated by the EPA. These materials must be segregated from other waste streams in suitable containers bearing Liquid Waste labels. On the label list the contents and percent composition. Acids should be neutralized, unless the neutralization process may release radioactive gases. Volatile materials that are flammable, explosive, or sublimate require extra caution. Any extra care required in handling must be indicated on the container.

2.24.10 INFECTIOUS WASTE

Radioactive, infectious agents should be inactivated or neutralized prior to release for disposal as radioactive waste. The Use Authorization for usage should address the proposed process for neutralization and disposal.

III. RADIATION GENERATING EQUIPMENT

3.0 INTRODUCTION

The policies and procedures of the Radiation Safety Manual apply to the use of radiation generating equipment governed by Chapters [3701:1-38](#), [3701:1-66](#), and [3701:1-68](#) of the Ohio Administrative Code (OAC). All radiation-generating equipment, whether active or in storage, must be registered with Ohio Bureau of Radiation Protection.

Radiation-generating equipment (also known as radiation-producing devices) consist of a wide variety of devices such as diagnostic, veterinary, and analytical x-ray units, as well as particle accelerators that are used for specific purposes in research and/or patient care. These facilities differ broadly in their potential for harm. This manual provides general guidance for safety and usage. Required operating procedures for each facility give more detailed information and procedures relevant to safety and regulatory compliance. The provisions of the Radiation Safety Manual and the operating procedures for each device constitute the Quality Assurance Program required by OAC [3701:1-66-04](#) and OAC [3701:1-68-02](#).

3.1 FACILITY COORDINATOR

A Facility Coordinator shall be named for each facility utilizing radiation-generating equipment. The Facility Coordinator administratively oversees and coordinates radiation-generating equipment operations and maintenance to ensure appropriate and safe usage. Additionally, the Facility Coordinator serves as a conduit for communications between the Radiation Safety Officer (and the Radiation Safety Committee) and the Faculty Users in matters concerning the radiation-generating equipment facility operations and safety.

3.1.1 FACILITY COORDINATOR QUALIFICATIONS

The Chair of the department housing the radiation-generating equipment facility nominates the prospective Facility Coordinator for approval by the University Radiation Safety Committee. The Facility Coordinator must be a faculty member (teaching or research) who has sufficient knowledge, experience, and administrative authority to reasonably assure safety, oversight, and control of the radiation-generating equipment.

3.1.2 FACILITY COORDINATOR RESPONSIBILITIES

- a) Develop operating procedures for the facility that satisfy the requirements from OAC [3701:1-66](#) (for Radiation Generating Equipment) and OAC [3701:1-68](#) (for Industrial Radiation Generating Equipment). The Radiation Safety Manual and Operating Procedures must be accessible to radiation-generating equipment operators at all times.
- b) Operating procedures must contain site-specific instructions, as well as manufacturer's instructions. Review the operating procedures periodically to ensure they are current. Communicate to Faculty Users any change in operating status of the device or required operating procedures. Submit changes in a memorandum to the Radiation Safety Officer.

- c) Establish and administer controls limiting access to each device to approved operators, as well as scheduling the use of radiation-generating equipment.
- d) Develop and maintain a use log for each radiation-generating equipment. Use log templates are available through the [Radiation Safety Office](#), upon request.
- e) Develop training programs for operators and any individual likely to receive a radiation exposure rate of 0.1 mrem/hr, not to exceed 100 mrem in a calendar year from the facility. Training will include [general radiation safety training](#) offered by the [Radiation Safety Officer](#) for all operators and users (see “Training Requirements” for details).
- f) Sign off on the adequacy of training and experience for Faculty Users, Facility Operators, Medical Operators, Student User, and Visitor User, for institutional accountability and quality assurance. There is a line on the forms for this signature.
- g) Arrange for appropriate maintenance of each device and schedule housekeeping services for the facility. **A record of maintenance is required.**
- h) Ensure that regular tests are made to verify the functioning of safety features as specified in the operating procedures. This includes the quarterly quality assurance check of the warning lights and interlock systems for each piece of radiation-generating equipment. **Record results in user's log.**
- i) Arrange with the [Radiation Safety Officer](#) for periodic surveys of the safety features of each device, and keep the [Radiation Safety Officer](#) informed of any changes that would affect the radiation output or safety aspects of any device.
- j) Inform the [Radiation Safety Officer](#) prior to the acquisition of additional or upgraded equipment or removal from service of old equipment to ensure that registrations with the Ohio Bureau of Radiation Protection are kept current.
- k) Immediately inform the [Radiation Safety Officer](#) and Department Chair of any situation resulting in or that could have resulted in personal injury.
- l) Inform the [Radiation Safety Officer](#) and Faculty Users of any significant modifications to existing equipment, facility alterations, or construction near the facility that may affect personnel safety or the adequacy of shielding.
- m) Complete EHS [general radiation safety training](#) for radiation-generating equipment, first initially, and annually thereafter, for as long as the Use Authorization is active.
- n) Name an interim facility coordinator in the event of sabbatical leave or any other situation when the Facility Coordinator is on an extended leave away from the university. The Radiation Safety Officer must be informed prior to such leave.

3.2 FACULTY USER

A Faculty User is a departmentally affiliated member of Wright State University, authorized by the Radiation Safety Committee, to use specific radiation-generating equipment independently and supervise subordinate operators. Research Use Authorizations must be submitted for Radiation Safety Committee approval before use of the radiation-generating equipment.

Operation of radiation-generating equipment must fully comply with research Use Authorizations approved by the Radiation Safety Committee. The Faculty User is responsible for the safe use of the equipment, including operation by anyone under his/her direction and protection of other personnel. Additionally, the Faculty User shall ensure that subordinate operators are familiar with Operating Procedures, have proper training to safely perform each assigned task, and can respond appropriately to emergency situations. Radiation-generating equipment use in research with human subjects must have approval from WSU's Institutional Review Board. Clinical and research use of radiation-generating equipment on human subjects must also obtain Radiation Safety Committee approval.

3.2.1 FACULTY USER QUALIFICATIONS

A prospective Faculty User must apply to the Radiation Safety Committee for approval. The applicant shall submit his/her training and experience on [Form RSO2](#). The Faculty User must:

- a) have 40 hours of training and experience operating similar radiation-generating equipment;
- b) possess a Radiation Safety Manual;
- c) review the manual, facility operating procedures and applicable Ohio Bureau of Radiation Protection rules with the Radiation Safety Officer, while paying close attention to Faculty User responsibilities, operator training, and other issues related to radiation-generating equipment usage and safety;
- d) ensure the training requirements for facility operator are fulfilled.

The Faculty User's experience with radiation-generating equipment should be reasonably current. The Radiation Safety Committee will judge the adequacy and currency of experience on a case-by-case basis.

An applicant who is otherwise qualified may gain experience using radiation-generating equipment as an operator under the supervision of an approved Faculty User. Upon written recommendation by the supervising Facility Coordinator, the Radiation Safety Committee may upgrade the applicant's status to Faculty User.

3.2.2 FACULTY USER RESPONSIBILITIES

- a) Ensure that operation, including that by subordinate operators, is compliant with the provisions of the facility operating procedures, approved Use Authorizations, and the Radiation Safety Manual.
- b) A Faculty User's Use Authorization to use radiation-generating equipment is not transferable to another Faculty User, unless approved by the Radiation Safety Committee. For instance, the research of a Faculty User planning to go on sabbatical

cannot be continued unless another Faculty User accepts the research and approved by the Radiation Safety Committee for a similar Use Authorization. The Faculty User is responsible for asking the [Radiation Safety Officer](#) to suspend a Use Authorization and make arrangements for continued work by subordinates under another Faculty User (as appropriate) if the Faculty User is to be absent from campus for more than 4 consecutive weeks.

- c) Provide sufficient training and supervision to subordinate operators such that they operate the device safely. The training must be documented on Form Radiation Safety Officer or a similar form designated in the Operating Procedures. Bystanders or visitors who may receive up to 100 mrem per year have must complete and document training on the [Laboratory Hazard Instruction](#) form.
- d) Never allow operation of radiation-generating equipment when unsafe conditions are evident. Do not operate radiation-generating equipment or immediately cease operations if a malfunction occurs that may affect safety (e.g., burnt out warning light, interlock failure, water near high voltage sources). Refrain from operations until the problem or malfunction is corrected. Take positive steps (e.g., post a "DO NOT USE" sign, "lock out/tag out" the unit) to ensure the unit is not used prior to repair. Immediately inform the Facility Coordinator.
- e) Keep the Radiation Safety Manual and Operating Procedures accessible to operators. Ensure operators under the Faculty User's direction are familiar with the emergency procedures for radiation-generating equipment.
- f) Submit Use Authorizations to the Radiation Safety Committee for research projects using the radiation-generating equipment and perform only projects that fall under the umbrella of an approved Use Authorization.
- g) Keep Use Authorizations current as procedures and operators change. Send updated information to the Radiation Safety Officer by memorandum. Review all current Use Authorizations for accuracy and any change that may affect radiation safety at least annually.
- h) Ensure all operators have appropriate dosimetry devices (e.g., OSLDs, finger rings, direct-read dosimeters) and check regularly on their use.
- i) Before operating any radiation-generating equipment, visually check and clear anyone in the exposure room (the room housing the radiation-generating equipment or its active element) who may be unnecessarily exposed to radiation. The visual check and clearing of people from the exposure room must be done prior to each use of the radiation-generating equipment.
- j) Inform the Radiation Safety Officer and Facility Coordinator immediately of any safety related incident that has or could have resulted in personal injury, even if it occurs after normal working hours.

- k) Ensure that facility logbook entries are recorded for routine use and "notable" events; e.g., malfunctions and repairs, unusual operating conditions. The use of electronic logs is acceptable if this is what the system uses.
- l) Ensure that the radiation-generating equipment is left with power "off" and locked after use with equipment and door to facility secured against unauthorized use.
- m) Complete EHS [general radiation safety training](#) for radiation-generating devices, first initially, and annually thereafter, for as long as the Use Authorization is active.

3.3 FACILITY OPERATOR

A Facility Operator is a departmentally affiliated member of the university, who operates radiation generating equipment for research purposes under the direction of a Faculty User with a limited degree of independence. The Facility Operator is responsible for the safe performance of his/her own activities. The Facility Operator can assist the Faculty User with training new operators in the lab. The Faculty User must apply to the Radiation Safety Committee to add a person to his/her Use Authorization as a Facility Operator. The Radiation Safety Committee grants approval of Facility Operator status based on completion of the operator's training. The Radiation Safety Officer may approve persons who are clearly qualified.

3.3.1 FACILITY OPERATOR TRAINING

The supervising Faculty User must:

- a) Submit the prospective operator's prior training and experience on [Form RSO2](#) to the [Radiation Safety Officer](#).
- b) Provide and document training to each new operator on the topics addressed in the Operating Procedures. The [operator completion form](#) must be used to document laboratory-specific and operational training specific to each radiation-generating device.
- c) Provide direct (observed) supervision for each operation until the Faculty User is confident that the prospective operator complies with the Operating Procedures and can work independently. The period of supervision depends on the perspective operator's performance and previous experience with similar devices. Experience must be documented on the [operator completion form](#) and signed by the Facility Coordinator.
- d) When training is complete, add the individual to the Faculty User's authorization by submitting a memorandum to the [Radiation Safety Officer](#) for approval/review by the Radiation Safety Committee.

3.3.2 FACILITY OPERATOR RESPONSIBILITIES

- a) Operate only radiation-generating equipment for which approval has been granted.
- b) Adhere to the safety rules and regulations as promulgated in this manual, facility Operating Procedures, and any communications from the Radiation Safety Committee.

- c) Wear issued radiation dosimeters when the radiation-generating equipment is operating. Return the dosimeters to the Radiation Safety Officer when use is discontinued.
- d) Operate the radiation-generating equipment in such a way as to keep radiation exposures As Low As Reasonably Achievable (ALARA).
- e) Before operating radiation-generating equipment, visually check and clear anyone from the exposure room [the exposure room is the room in which the radiation-generating equipment is located] who may be unnecessarily exposed to radiation.
- f) Ensure that the radiation-generating equipment is left with power "off" after use with equipment. Remove key, if possible, or lockout/tag out equipment. Make sure the door to facility secured against unauthorized use.
- g) Inform the [Radiation Safety Officer](#) and the Faculty User immediately of any safety related incident that has or could have resulted in personal injury, even if it occurs after normal working hours.
- h) Ensure that facility logbook entries are recorded for routine use and for "notable" events; e.g., malfunctions and repairs, unusual operating conditions.
- i) Report any malfunctions or unusual operating conditions to the responsible Faculty User and the Facility Coordinator.
- j) Complete EHS [general radiation safety training](#) for radiation-generating equipment, first initially, and annually thereafter, for as long as the Use Authorization is active.

3.4 MEDICAL OPERATORS

A Medical Operator is a departmentally affiliated member of the university who uses radiation-generating equipment under the direction of a Faculty User approved for clinical or research use on human subjects. All use of radiation-generating equipment on live humans **MUST** have an approved Institutional Review Board Use Authorization when using equipment for research purposes. A Medical Operator must hold either a Radiographers or an X-ray Machine Operators license issued by the Ohio Department of Health to operate an x-ray unit used to expose humans, excluding cadavers, to the primary beam. The Medical Operator is responsible for the safety of the patient, compliance with the facility operating procedures, and acting in a safe manner. The Faculty User must apply to the Radiation Safety Committee to add a person to his/her Use Authorization as a medical radiation-generating equipment operator. Approval of Medical Operator status is granted by the Radiation Safety Committee based on completion of licensure and fulfillment of training specified in the facility Operating Procedures. Subject to review by the Radiation Safety Committee, the [Radiation Safety Officer](#) may approve persons who are clearly qualified.

3.4.1 MEDICAL OPERATOR TRAINING

The Faculty User must:

- a) Submit the prospective operator's prior training and experience on [Form RSO2](#) to the [Radiation Safety Officer](#).
- b) Ensure the individual has a Radiographers or a General X-ray Machine Operators license.
- c) Provide and document training to each new operator on the topics addressed in the Operating Procedures. The [operator completion form](#) may be used if the operator will likely receive a total effective dose equivalent of 100 mrem per year. Complete [general radiation safety training](#) provided by the [Radiation Safety Officer](#).
- d) Provide direct (observed) supervision for each operation until the Faculty User is confident that the prospective operator complies with the Operating Procedures and can work independently. The period of supervision depends on the prospective operator's performance and previous experience with similar devices.
- e) When training is complete, the Facility Coordinator must document and sign off before adding the individual to the Faculty User's authorization. The individual can be added to a Use Authorization by a Faculty Operator by submitting a memorandum to the [Radiation Safety Officer](#) for approval/review by the Radiation Safety Committee.

3.4.2 MEDICAL OPERATOR RESPONSIBILITIES

- a) Operate only radiation-generating equipment for which approval has been granted. Maintain licensure in accordance with OAC [3701-72](#). Notify the Facility Coordinator if the operator's license has expired or has been taken away for any reason.
- b) Adhere to the safety rules and regulations as promulgated in this manual, facility Operating Procedures, and any communications from the Radiation Safety Committee.
- c) Wear issued [radiation dosimeters](#) when radiation-generating equipment is operating. Return the dosimeters to the [Radiation Safety Officer](#) immediately when use is discontinued.
- d) Operate radiation-generating equipment in such a way as to keep radiation exposures for all personnel, including the patient, As Low As Reasonably Achievable (ALARA).
- e) Before operating any radiation-generating equipment, visually check and clear anyone from the exposure room (room where radiation-generating equipment is located) who may be unnecessarily exposed to radiation.
- f) Ensure that radiation-generating equipment is secured against unauthorized use. Remove any keys or use lockout/tag out procedures to ensure the equipment is tamper-proof. Ensure all entry doors are locked.

- g) Inform the [Radiation Safety Officer](#) and the Faculty User immediately of any safety related incident that has or could have resulted in personal injury, even if it occurs after normal working hours.
- h) Inform the Facility Coordinator and [Radiation Safety Officer](#) if any certified components fail. Certified components must be replaced by certified components.
- i) Report any malfunctions or unusual operating conditions to the responsible Faculty User and the Facility Coordinator.

3.5 STUDENT OPERATOR

There may be instances when a student will take a semester course with the opportunity to use radiation-generating equipment in the laboratory. Student users can be listed as Facility Operators but would generally be considered “training-under-observation” and thus will never become independent operators placed on a research Use Authorization without additional, in-depth tutelage or permission of the [Radiation Safety Officer](#). Student operators must complete the [general radiation safety training](#), as well as machine-specific training. Student Operators must follow the same guidelines as the Facility Operator, listed above.

3.6 EMERGENCY RESPONSE

Any unusual event that may injure an individual or damage the radiation-generating equipment or the facility must be handled immediately to prevent the situation from becoming worse. Some potential emergency situations include electrical shock, accidental radiation exposure, fire in the facility or elsewhere in the building, detection of fumes, unusual sounds, water leaks, and smoke.

Situations involving severe or life-threatening injuries can vary significantly. The outcome of an emergency depends largely on the actions taken by the persons present. The following list of actions prescribes general guidance for emergency response. Key to any reaction is for the responder to act calmly and rationally. The operating procedures for each facility may address specific actions expected of operators in the event of an actual emergency. The event should be recorded in detail in the Use Log or by memorandum to the Facility Coordinator and Radiation Safety Officer as soon as possible after the situation is under control.

- a) **Shut down the radiation-generating equipment.**
- b) If personal radiation exposure is suspected, avoid changing the operating parameters. This information may be necessary to reconstruct exposure conditions.
- c) **IMMEDIATELY NOTIFY the [Radiation Safety Officer](#), Facility Coordinator, and Faculty User.** The Facility Coordinator or Faculty User will immediately notify the Department Chair.
- e) **If injuries are suspected:**
 - (1) **Serious Injuries.** The university procedures for injuries and illnesses are outlined in [Wright Way Policy 6031](#). Immediate assistance for serious injuries should be

- sought. On the main campus call the Public Safety Communications Center by dialing 2111 or 911, or use any emergency telephone located in the corridors throughout the campus. For off-campus laboratories, either use the medical facilities immediately available or call the local paramedics for assistance.
- (2) **Minor Injuries.** Consult [Wright Way Policy 6031](#).

- e) **Ensure the unit cannot be used** until the problem is resolved by removing facility keys. Post a sign, "DO NOT USE" on the console, if circumstances permit. Only the [Radiation Safety Officer](#) can remove a "DO NOT USE" sign. Disconnect the system from the electrical power, if safely feasible.

3.7 THE ACQUISITION OF RADIATION-GENERATING EQUIPMENT

The purchase or receipt of radiation generating equipment shall be coordinated with the [Radiation Safety Officer](#) during the initial planning stages to ensure that the facility is adequately shielded and the device can be properly registered with the Ohio Bureau of Radiation Protection as mandated by the Vice President of Research and Graduate Studies. Installed radiation-generating equipment may not be operated, other than for controlled, preliminary, installation tests, until all safety interlocks and warning devices are fully operational, administrative requirements have been met, and acceptance tests have been performed by the [Radiation Safety Officer](#) or other qualified person approved by the Radiation Safety Committee.

3.8 TRAINING REQUIREMENTS

Training requirements are listed under each type of user description. The operators of radiation-generating equipment require initial and annual [refresher radiation safety training](#). Scanning electron microscopes and photoelectron spectrometers are **excluded** from these requirements and are given a document summarizing the hazards of use for equipment type. The Facility Coordinator or the Faculty User must be available during the review of the training topics and must initial the training sheet beside the Facility Operator's name when the review is complete. The training roster must be kept in the user's log easily accessible by the [Radiation Safety Officer](#) and the inspectors from the Ohio Department of Health. Obtain the training roster form by contacting the [Radiation Safety Office](#).

3.9 TRAINING FOR COLLEGE ADMINISTRATORS, COLLABORATORS, AND VISITORS

Bystanders and visitors (such as members of the Wright State University Administrative offices [i.e. Vice-Presidents, Deans, Department Chairs] students, maintenance or custodial personnel, and members of the general public) must receive instruction in accordance with OAC [3701:1-38-10\(B\)](#). A [Laboratory Hazard Instruction form](#) or training implemented in the facility operating procedures provides acceptable criteria and documentation to fulfill this requirement.

3.10 TRAINING FOR SCANNING ELECTRON MICROSCOPES AND PHOTOELECTRON SPECTROMETERS

Scanning electron microscopes and photoelectron spectrometers use electrons to image very small features. Ancillary to this imaging is the production of x-rays. These X-rays are fully shielded within the microscope's housing. The x-ray housing has been checked for radiation leakage and none has been observed. Operators and observers of scanning electron

microscope and of photoelectron spectrometers should not receive radiation exposure in excess of natural background doses from this facility.

Facility Coordinators whose inventory includes scanning electron microscopes or photoelectron spectrometers are required to use the radiation-generating equipment-specific form via the [Radiation Safety Office](#) for training purposes. The topics of the training are included on the back of the form. Training must also include machine-specific training. Facility Coordinators and Operators must sign off on the training form before the initial use of each specific unit. Please store the training form in the user logbook for each instrument for easy access to the [Radiation Safety Officer](#) and Ohio Department of Health inspectors.

Operators of scanning electron microscopes and photoelectron spectrometers are not required to complete the general radiation safety training offered by the Radiation Safety Officer. Operators of transmission electron microscopes ARE required to complete the [general radiation safety training](#) for radiation-generating equipment offered by the [Radiation Safety Officer](#).

3.11 EXPERIMENTAL RADIATION GENERATING EQUIPMENT USE AUTHORIZATIONS

3.11.1 APPLICATIONS FOR RADIATION GENERATING EQUIPMENT USE AUTHORIZATIONS

A Radiation Generating Equipment Use Authorization is a written form of communication between a Faculty User and the Radiation Safety Committee. The Use Authorization application briefly describes how the radiation-generating equipment will be used, with a commitment to follow the facility operating procedures, as well as any other safety measures that will be taken. The Application for Use of Radiation-Generating Equipment (Form RSO3A) must be reviewed by the Facility Coordinator and Radiation Safety Officer and approved by the Radiation Safety Committee **prior to using** the radiation-generating equipment. The Radiation Safety Officer may grant interim approval pending assembly of the Radiation Safety Committee. The Radiation Generating Equipment Use Authorization application must show that anticipated radiation exposures will be consistent with ALARA.

Once approved, the Radiation-Generating Equipment Use Authorization will be valid for five years. Upon the date of the fifth year, the Use Authorization will expire and must be renewed in order to continue the project. The Use Authorization will be terminated *30 days* after the anniversary date of approval and the equipment will be locked out/tagged out by the Radiation Safety Officer or qualified Environmental Health and Safety personnel.

The Radiation Safety Committee will review the Radiation Generating Equipment Use Authorization, specifically consider the adequacy of facility shielding with the equipment to be used, operating and emergency procedures, and the training and experience of proposed operators. The submitted Radiation Generating Equipment Use Authorization for use of radiation-generating equipment will address the topics listed below. Consult with the Radiation Safety Officer (ext. 2169) if you have questions regarding the Radiation Generating Equipment Use Authorization application.

- a) *list the personnel involved*, include a Form RSO2 for operators who have previous training and experience. Ensure they have appropriate training or licensure as specified in the operating procedures.
- b) *list all radiation-generating equipment* that will be used in the study, *type(s) of radiation* (e.g., x-ray, electrons) *and energy*, the *exposure monitoring devices* (e.g., TLD), *area survey equipment* (e.g., Geiger-Müller detector), and the *location* of the radiation-generating equipment.
- c) *briefly describe the proposed use*. Address procedures (specify a commitment to follow the facility operating procedures or address special procedures that will be used), materials or subjects to be irradiated, and safety precautions. Also consider:
 - (1) For clinical and research x-ray units for use with human subjects- approval from the Institutional Review Board is obtained?
 - (2) Do you plan to use animals or biological agents?
 - (3) Are any non-radiation concerns for safety evident (e.g., handling high voltages or hazardous chemicals)?
 - (4) Is there a potential for ozone or other hazardous gas production? Is the ventilation adequate?

3.11.2 CHANGES IN THE RADIATION GENERATING EQUIPMENT USE AUTHORIZATION

- a) Minor Changes. An example of a minor change of a Radiation Generating Equipment Use Authorization is adding or deleting an operator. Minor changes require a memorandum from the Faculty User to the Radiation Safety Officer indicating the change and briefly explaining the reason. The Radiation Safety Officer may approve the change, subject to review by the Radiation Safety Committee.
- b) Significant Changes. Radiation Generating Equipment Use Authorization changes where the procedures or project scope differ significantly from the existing use Radiation Generating Equipment Use Authorization s approved by the Radiation Safety Committee (e.g., changes from previous operating conditions, shielding changes, change in facility design) require the submission an additional Radiation Generating Equipment Use Authorization application form (Form RSO3A). The Radiation Safety Officer may provisionally approve the change, pending final approval by the Radiation Safety Committee.

3.11.3 SUSPENSION OF THE RADIATION GENERATING EQUIPMENT USE AUTHORIZATION

Facility Coordinators who are not currently using radiation-generating equipment, but may do so in the foreseeable future may place their Radiation Generating Equipment Use Authorization in suspension by informing the Radiation Safety Officer in writing. The Facility User must give ample (i.e., about two weeks) notice to the Radiation Safety Officer when radiation-generating equipment usage will be restarted. All equipment will be locked out/tagged out during the suspension period.

3.11.4 TERMINATION OF THE RADIATION GENERATING EQUIPMENT USE AUTHORIZATION

Radiation Generating Equipment Use Authorizations expired on the fifth year date of approval by the Radiation Safety Committee and are terminated 30 days later.

Facility Coordinators and Faculty Users who plan to discontinue using the radiation-generating equipment or end their university affiliation must terminate their Radiation Generating Equipment Use Authorization by:

- a) informing the Radiation Safety Officer of termination plans.
- b) returning all facility keys to the Facility Coordinator, Department Chair, or Radiation Safety Officer.
- c) returning the Radiation Safety Manual and dosimetry to the Radiation Safety Office.

3.12 PROTECTIVE MEASURES FROM EXPOSURE

3.12.1 TIME, DISTANCE, AND SHIELDING

Use of the principles of time, distance, and shielding can significantly reduce personal exposure to levels that are *as low as reasonably achievable* (ALARA). Practical applications include using lead aprons for fluoroscopy and standing clear of primary radiation beams and radiation areas.

- a) **TIME:** Radiation exposure can be decreased by reducing the amount of time people spend working in radiation fields.
- b) **DISTANCE:** X ray intensity decreases inversely with the square of the distance ($1/d^2$) when the source is small compared to the distance. For instance, if you double your distance from a radiation source, you reduce your exposure by (1/4) one-fourth. The radiation intensity decreases more slowly for large radiation-generating equipment or planar sources.
- c) **SHIELDING:** Attenuating material placed in the radiation path can effectively reduce external dose. The thickness of shielding needed is determined by the type and energy of radiation, type of shielding material, distance from the source, time spent in the work area, and acceptable level of dose reduction. The adequacy of the shielding is evaluated by the [Radiation Safety Officer](#) and verified using a survey meter. The exposure rate to the user should be reduced to 1 mrem/hr or less for long procedures. The exposure rate in any unrestricted area must not exceed 2 mrem/hr. Dose to members of the public must be restricted to less than 100 mrem/year. In the interest of ALARA the exposure rate in any unrestricted area should be consistent with background. Information on the attenuating characteristics of shielding materials can be obtained from the [Radiation Safety Officer](#).

Inform the [Radiation Safety Officer](#) if facility changes (e.g., structural changes, moving radiation-generating equipment, increasing operating voltage range, construction

around the facility) are contemplated or in progress so that the potential impact on shielding can be evaluated.

3.12.2 GENERAL PRECAUTIONS WHEN USING RADIATION-GENERATING EQUIPMENT

- o Never expose fingers, hands, or any other body part to the primary beam. No person may be intentionally exposed to the primary beam, except a patient who has a physician's order or Institutional Review Board approval. This restriction applies to training, demonstrations, and any other non-medical diagnostic purpose.
- o Never disengage a safety interlock (except as described by an approved Use Authorization) or warning device or operate a unit if one of these systems malfunctions.
- o Use time, distance, and shielding to minimize your exposure.
- o Properly wear dosimetry, if issued, whenever the radiation-generating equipment may be energized.
- o Record radiation-generating equipment usage and maintenance in a facility logbook, according to operating procedures.
- o Never energize electrical equipment if the floor or equipment is wet or if high voltage wires are exposed.
- o Never operate equipment for which you have not been trained.
- o Never alter, repair, or perform maintenance on radiation-generating equipment component(s) without authorization and approval from the Facility Coordinator.

3.12.3 ADDITIONAL PRECAUTIONS FOR MEDICAL RADIATION-GENERATING EQUIPMENT

- o The operator must remain behind the control shield during exposures, when applicable. Persons needed to attend to the patient (e.g., parents) must stay behind the operator's control shield or at least 2 meters from the x-ray tube during the exposure.
- o Use mechanical restraints for difficult patients. If the patient must be held, use a parent (or adult relative) wearing a lead apron. Lead gloves are required if the restraining person must place their hands near the primary beam. No person will routinely hold patients.
- o Operators must use the fastest screen / film combination. Cassettes without intensifying screens cannot be used.
- o The source-image distance cannot be less than 30 cm.
- o Grids must be installed and used properly.
- o Processing solutions must be made and films must be processed according to manufacturer's specifications. Do not use expired film.

3.13 LOCATIONS OF USE

Each location having radiation-generating equipment must be registered by [Radiation Safety Officer](#) with the Ohio Bureau of Radiation Protection. The operation of each radiation-generating equipment is contingent upon verification of the adequacy of shielding, interlocks, warning devices, ventilation equipment, and personnel protection equipment by the [Radiation Safety Officer](#). Inform the [Radiation Safety Officer](#) well in advance should it become necessary or desirable to change the location or dispose of radiation-generating equipment, whether it is operational or not.

3.14 FACILITY OPERATING PROCEDURES

The Radiation Safety Manual does not address specific concerns for each unit of radiation-generating equipment. As an extension of the Radiation Safety Manual, *Operating Procedures* provide guidance to radiation-generating equipment operators on facility procedures and safety requirements. The Facility Coordinator promulgates the Operating procedures. The procedures should be reviewed periodically by the [Radiation Safety Officer](#) and Facility Coordinator for possible updating or changes. Operating procedures must be present in the facility and accessible to all approved operators.

Since each radiation-generating equipment facility has distinctly different levels of concern, the operating procedures must address safety items that are specific to the facility. Any special precautions to enhance safety (e.g., access control, emergency response, usage) should be clearly communicated. The procedures should contain the following information, as applicable or if augmented from the conditions of this manual:

- a) a brief description of the facility design and purpose.
- b) any limits to operations.
- c) training requirements.
- d) responsible parties and responsibilities.
- e) security.
- f) use log.
- g) safety interlocks and warning devices.
- h) good safety practices.
- i) dosimetry requirements.
- j) radiation detectors available for use.
- k) general safety concerns (e.g., electrical, noxious gases, lifting).
- l) maintenance, repairs, system alterations, lock out/tag out procedures.
- m) emergency procedures.
- n) checklists for start-up, operation, shutdown, testing interlocks and warning devices.

3.15 USE LOG

A record of radiation-generating equipment usage must be maintained to document routine operations and unusual events. The presence of visitors, students, or trainees must be recorded. This record should be retained indefinitely.

- a) Routine Entries. Routine entries (depending on the type of unit) may include date, operator, operating parameters (e.g., kVp, mA), duration of exposure, or any other relevant information.
- b) Testing of Interlocks. Whenever system interlocks or warning devices are tested, the result of that test must be logged.
- c) Maintenance or Repairs. A record of maintenance and repairs should also be maintained. If the unit is inoperable or unsafe to operate, the record should indicate the status and what measures were taken to prevent operation.
- d) Unusual Events. Unusual events may include irregular sounds, presence of fumes, vapors, or smoke, malfunction of components, or suspected injury to an individual.

3.16 TESTING OF SAFETY DEVICES

3.16.1 ROUTINE TESTING

The proper function of safety interlocks, visible and audible warning devices, emergency interrupt devices, radiation level monitors and key-lock or security shutoff switches will be verified at least:

- a) once each quarter when the device is not routinely operated; or
- b) prior to use after maintenance, repairs, or alteration that may affect safety device operation; and
- c) prior to each use

A record of the verification, observations and description of any repairs found necessary will be entered in the facility's use log.

3.16.2 SAFETY DEVICE FAILURE

Any time a safety device fails to operate properly, all operations in the facility must be immediately terminated. Implement lock out/tag out procedures (if applicable). Post a "DO NOT USE" sign on the console and make an entry in the Use Log regarding the failure. The Facility Coordinator must be notified. The [Radiation Safety Officer](#) must be notified if anyone has or may have received an unplanned radiation greater than the ALARA levels. Once the problem is corrected, the safety devices will be tested again and results logged. The Facility Coordinator is the only person who can remove the "DO NOT USE" sign when the safety devices are shown to be operational.

3.16.3 SAFETY DEVICE BY-PASS

No safety or warning device may be defeated or by-passed during routine operation. Jumpers, interlock plugs, or other devices that may defeat safety or warning systems will be conspicuously tagged and a notice of its installation posted (e.g., a "DO NOT USE" sign, implement the university lock out/tag out procedures) at the control panel of the radiation generating equipment. An entry in the Use Log must be made stating which safety device(s) has been over-ridden and for what purpose. After service or repair has been completed, the safety and warning equipment will be tested to verify proper operation. A log entry will be made stating that the facility is fully operational and safety devices have been tested. Only the Facility Coordinator may remove a "DO NOT USE" sign.

3.17 MAINTENANCE AND REPAIRS

The Facility Coordinator must authorize all repairs, maintenance, and facility alterations. Any change that may affect personal safety or radiation exposure, facility design, or shielding must be submitted to the [Radiation Safety Officer](#) for evaluation and to the Radiation Safety Committee for approval.

Manufacturer representatives, contracted maintenance and repair specialists may only make maintenance and repairs, or persons approved by the Facility Coordinator who have the training and experience to make repairs safely. The Facility Coordinator must approve the procedures for maintenance and repairs. Implement "lock out/tag out" procedures, if applicable. A "DO NOT USE" sign must be posted on the unit's console and a log entry made to record the respective repairs. When the unit is operational and the safety interlocks are tested, a log entry is made. Only the Facility Coordinator may remove the "DO NOT USE" sign when the facility is fully operational.

3.18 SECURITY

Radiation producing devices will be secured against tampering and unauthorized operation. The controls of the device will be inaccessible, locked, disconnected or otherwise disabled, or positively secured when not under the physical supervision of an approved operator.

In special circumstances, equipment may be operated while unattended; so long as positive security against unauthorized entrance to radiation areas and the operating controls are maintained. Conditions for unattended operation should be clearly stated in the operating manual. Two requirements for unattended operation are:

- (1) the entryway must be locked and safeguarded against unauthorized entry and;
- (2) a notice must be posted at the entryway informing departmental and emergency personnel of necessary precautions and actions in case of an emergency.

3.19 POSTING / LABELING WARNING SIGNS

Warning signs and labels heighten the awareness of persons who may enter the lab and alert them of possible or eminent dangerous conditions. They provide a constant reminder for operators, custodians, and maintenance personnel to exercise caution and responsible action.

3.19.1 POSTING AT LAB ENTRYWAYS

- a) Radiation Area. A warning sign bearing the radiation symbol and "Caution Radiation Area" will be conspicuously posted at the entrance to an accessible area where a person could receive 5 millirem (0.05 mSv) in one hour at 30 cm from the radiation source or its shielding.
- b) High Radiation Area. A warning sign bearing the radiation symbol and "Caution High Radiation Area" will be conspicuously posted at the entrance to any accessible area where a person could receive 100 millirem (1mSv) in one hour at 30 cm from the radiation source or its shielding.

- c) Notice to Employees. Ohio Department of Health [form 4786.32](#) "*Notice to Employees*", must be visibly posted in or near laboratories where radiation-generating equipment is located.
- d) Damaged Signs. The Facility Coordinator will notify the [Radiation Safety Officer](#) for replacement if any posted form is found defaced, altered, or removed.

3.19.2 WARNING ON CONTROL PANEL

The control panel of a radiation generating equipment will be labeled with the notice, "Caution: This machine produces radiation when energized." or similar words appropriate for the radiation-generating equipment.

3.20 VENTILATION

Ventilation of air from the operation of high-energy particle accelerators may yield noxious gases, such as ozone and nitrous oxide. Significant accumulation of noxious gases can occur in poorly ventilated high radiation areas. Radiation in closed containment vessels can generate especially high concentrations of noxious gases, which must be vented to the atmosphere outside the building. Radiation interaction with some gases, such as SF₆, can increase their toxicity. Irradiation of some solids or liquids may produce noxious decomposition products. Experimental Use Authorizations must address such reactions, if applicable, so that the [Department of Environmental Health and Safety](#) can evaluate the proposal for appropriate controls. The Facility Coordinator will develop procedures, which may include restrictions to operations, based on recommendations by EHS staff for compliance with air quality requirements.

3.21 EXPOSURE RATE MONITORING

Facilities that have portable survey meters for area monitoring should use them periodically to verify the radiation exposure levels in occupied areas are consistent with ALARA. More frequent surveys may be required by facility procedures. If an operator questions whether radiation production has ceased, a survey of potential exposure must be made prior to entry.

- a) Meter Appropriation. Facility Coordinators are encouraged to acquire their own instruments for routine use from research or departmental funds. Survey meters are available for a wide variety of uses. The [Radiation Safety Office](#) can assist researchers with selection of the appropriate instrument for the intended purpose. For special applications, survey meters that are satisfactory for most purposes are available on loan from the [Radiation Safety Office](#).
- b) Calibration / Repair. Survey meters must be calibrated annually or biennially, in accordance with Ohio Department of Health rules. The Radiation Safety Office ensures this service is provided. The cost of repair or replacement of instruments damaged through misuse or careless handling is the responsibility of the laboratory. The calibration should be verified after significant repairs are made or the detector's response to radiation is questioned.

- c) Operational Checks. Prior to use, the survey meter should be checked to ensure it is operating properly. Check the:
 - (1) *Battery condition*. If low, change the batteries. Consult the Radiation Safety Officer if you have questions. Changing the battery does not require calibration.
 - (2) *Calibration label*. The instrument must be calibrated within 1 year (meters used with some radiation generating equipment and all industrial radiation generating equipment require calibrating every 6 months).
 - (3) *Meter response*. Ensure the meter responds properly to the source on the side, if applicable.
- d) Monitoring Procedures. Use the open window part of the probe for maximum detectability. Move the detector slowly. Using the audio (if available) facilitates detection at background levels. Sporadic counts may be due to cable movement. Areas where this occurs should be monitored again with the detector movement suspended until the reading can be made. Log results that are distinguishable from background. If results exceed 2 mR/hr, notify the Facility Coordinator and [Radiation Safety Officer](#).

3.22 FACILITY EVALUATIONS

The [Radiation Safety Officer](#) surveys each facility containing radiation-producing equipment soon after installation to ensure compliance with Ohio Bureau of Radiation Protection rules. The survey will evaluate administrative and engineering controls, such as interlocks, warning devices, operating and emergency procedures, security, and shielding. Radiation exposure levels in areas that may be occupied during operation are also recorded. Each facility will be re-evaluated either annually or as required. Surveys will also be conducted when significant modifications are made to the facility or near the facility that may affect the integrity of shielding. The Facility Coordinator must notify the [Radiation Safety Officer](#) when such changes are expected or suspected.

The survey results are reported to the Facility Coordinator who will ensure corrective actions are made. If the facility is considered unsafe to operate, the Facility Coordinator will ensure that the facility is closed and positive measures are taken to prevent operation until repairs rectify the problem.

The Ohio Bureau of Radiation Protection inspects each operational unit periodically. For most radiation-generating equipment this period is every three years. Bills for this service are forwarded to the respective department for payment. Timely remittance is encouraged. If the invoice is not paid within 90 days of the invoice date, the fee doubles.

3.23 DISPOSAL OF RADIATION-GENERATING EQUIPMENT

The Facility Coordinator must notify the [Radiation Safety Officer](#) whenever radiation-generating equipment is planned for disposal or permanently disabled so that proper administrative procedures may be followed. Radiation-producing equipment may be disposed by transferring the unit to another facility by sale or donation or the unit may be scrapped as waste.

The [Radiation Safety Officer](#) must notify the Ohio Bureau of Radiation Protection of the disposition of the unit and the state registration will need amended. If the unit is transferred to an Ohio facility, the [Radiation Safety Officer](#) should inform the new owner of the need to register the device. If the unit is disposed as scrap, the x-ray tube(s) must be de-activated and any hazardous chemicals or materials treated or removed prior to disposal.