UNIVERSITY AT ALBANY

STATE UNIVERSITY OF NEW YORK

RADIATION SAFETY MANUAL

REQUIRED PROCEDURES FOR RADIATION PROTECTION

Submitted by:________________________________
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Reviewed by:_________________________________
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Approved by:_________________________________
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Eric R. Call	(Home)	489-8642
Director of EH & S		2-3495
Vincent T. Franconere	(Home)	729-2793
	(Cell)	788-2406
Assistant Director, NAL		2-4480
Arthur W. Haberl	(Home)	370-5888
Power Plant (24 hours)		2-3444

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RADIATION SAFETY COMMITTEE

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GENERAL RESPONSIBILITIES / AUTHORITY FOR RADIATION PROTECTION

PURPOSE

The required procedures contained in this document have been established for the following purposes:

A. To provide for the protection of the University population and of the general public against radiation hazards associated with: a) the University's possession, use, transportation, and disposal of radioactive materials; and b) the University's use of machines and equipment that emit radiation.

B. To provide for University compliance with applicable regulations of Federal, State, and Local agencies.

DELEGATION OF AUTHORITY

The ***Radiation Safety Committee*** receives its authority from the Office of the President of the University.

The Committee is charged with the following responsibilities:

1. The establishment and continuing review of an adequate radiation protection program at the University and its off-campus sites.

2. University compliance with radiation protection regulations promulgated by Federal, State, and local agencies.

3. Ensure that all individuals who work with or in the vicinity of radioactive material and/or radiation producing equipment have sufficient training and experience to enable them to perform their duties safely and in accordance with Health Department regulations and the conditions of our license.

4. Ensure that all use of radioactive material and/or radiation producing equipment is conducted in a safe manner and in accordance with Department regulations and the conditions of our license.

To meet these responsibilities, the Committee has been given the following authority:

1. To grant authorization, after appropriate application, to an individual or department for the use of radioactive materials and/or equipment that emits radiation on University property.

2. To suspend an individual's University authorization to use radioactive material or equipment that emits radiation.

3. To apply restrictions on the amount of occupational radiation exposure that an individual may receive during his University association.

The Committee shall:

1. Be familiar with all pertinent New York State Health Department regulations, the terms of the license, and information submitted in support of the request for the license and its amendments.

2. Review the training and experience of all individuals who use radioactive material and determine that their qualifications are sufficient to enable them to perform their duties safely and in accordance with New York State Health Department regulations and the conditions of the license.

3. Be responsible for monitoring the institution's program to maintain individual and collective doses As Low As Reasonably Achievable (ALARA).

4. Review semi-annually, with the assistance of the Radiation Safety Officer, occupational radiation exposure records of all personnel working with radioactive materials.

5. Establish a table of investigational levels for occupational radiation exposure, which when exceeded, will initiate an investigation and consideration of action by the Radiation Safety Officer.

6. Establish a program to ensure that all individuals whose duties may require them to work in the vicinity of radioactive material and/or radiation producing equipment (e.g., security and housekeeping personnel) are properly instructed as required by Section 16.13, New York State Sanitary Code (10 NYCRR 16).

7. Review and approve all requests for use of radioactive material and/or radiation producing equipment within the institution.

8. Prescribe special conditions that will be required during a proposed use of radioactive material such as requirements for bioassays, physical examinations of users, and special monitoring procedures.

9. Review the entire radiation safety program at least annually to determine that all activities are being conducted safely and in accordance with New York State Health Department regulations and the conditions of the license. The review shall include an examination of all records, reports from the Radiation Safety Officer, results of New York State Health Department inspections, written safety procedures, and the adequacy of the institution's management control system.

10. Recommend remedial action to correct any deficiencies identified in the radiation safety program.

11. Maintain written records of all Committee meetings, actions, recommendations, and decisions.

12. Ensure that the radioactive materials license is amended, when necessary, prior to any changes in facilities, equipment, policies, procedures, radioactive material, possession limits, and personnel, as specified in the license.

Meetings:

1. The Radiation Safety Committee shall meet as often as necessary to conduct its business, but not less than once in each calendar quarter.

2. A quorum shall consist of at least one-half of the Committee's membership, including the Radiation Safety Officer and the management representative.

The ***Radiation Safety Officer*** is responsible for developing and making recommendations on policies and procedures for a broad program in radiation safety and is to implement those programs and policies as approved by the Radiation Safety Committee.

The Radiation Safety Officer has the following duties and responsibilities:

1. Be a member and secretary of the Radiation Safety Committee and maintain records on Committee deliberations.

2. Keep current and maintain the file for the University's radiation equipment registrations and radioactive materials license.

3. Review protocols and applications for authorized use of radioactive materials and/or radiation producing equipment under the license/permit and provide assistance in completing such applications.

4. Be responsible for supplying advice and assistance on all matters involving the use of radioactive materials and other radiation sources.

5. Interpret and implement regulations which govern the use of sources of radiation.

6. Maintain an up-to-date manual of safety regulations and procedures for the University and advise the Radiation Safety Committee of any needed changes.

7. Coordinate the dosimetry service and maintain personnel exposure records. Be responsible for the timely notification of exposures to the supervisor, as well as individuals exposed when abnormal results are received or upon request.

8. Be responsible for the procurement, receipt, delivery and shipment of all radioactive materials and all radiation producing equipment coming to or leaving the University. No quantity of radioactive material may be considered exempt under our University-wide broad license.

9. Maintain records on procurement and receipt of radioactive materials and of radiation producing equipment.

10. Be responsible for the supervision of radioactive waste disposal. The Radiation Safety Officer shall provide current information concerning all aspects of radioactive waste disposal.

11. Maintain radioisotope disposal records and records of transfer of any radiation producing sources.

12. Maintain an inventory of all radionuclides at the institution and limiting the quantities of radionuclides to the amounts authorized.

13. Instruct individuals on proper procedures for handling radioactive materials and radiation producing equipment. Be available for consultation on laboratory design, shielding and other radiation exposure control methods.

14. Oversee the completion of periodic radiation surveys and wipe tests in laboratories and storage areas. The RSO generally conducts periodic surveys of work areas to supplement and audit routine monitoring by authorized users.

15. Conduct periodic leak tests of sealed sources pursuant to applicable regulations and maintain the necessary records.

16. Be responsible for calibration of monitoring and survey instruments under his/her supervision.

17. Conducting training programs and otherwise instructing personnel in the proper procedures before they are allowed to use radioactive material and/or radiation producing equipment.

18. Verify and report to appropriate authorities any incident involving sources of radiation when required by applicable regulations.

19. Note and take steps in order to correct laboratory and general radiation safety problems.

20. Perform duties of Radiation Safety Officer as listed in State Sanitary Code Chapter 1, Part 16.

21. Direct and prescribe decontamination procedures. Provide assistance with decontamination in emergency cases, and maintain an adequate inventory of decontamination supplies.

The ***Principal Investigator*** is responsible for the protection of personnel listed on his protocol, prevention of contamination of University facilities, and compliance with all rules and regulations of Federal, State, Local and University regulations.

The following responsibilities are required to be met as specified:

1. Provide adequate planning of experiments so that all necessary precautions may be taken before, during and after the execution of the experiment.

2. Comply with all radiation protection guidelines for safe handling of radioactive material and radiation producing equipment.

3. Conduct and document initial training for all laboratory personnel on local laboratory policies and safety procedures. Conduct and document annual refresher training of these policies and procedures highlighting new regulatory changes and University policy changes.

4. Notify the Radiation Safety Officer of changes which may possibly affect radiation safety requirements, such as (but not limited to); changes in personnel, changes in room use, changes in experimental technique, problems in the receipt, use or disposal of radioactive material/radiation producing equipment.

5. Limit participation in the use of radioactive material and/or radiation producing equipment to those persons listed on the protocol (associates, technicians, students, post-doctorates etc.).

6. Maintain adequate inventory of the amount of unsealed sources of radioactive material possessed and ensuring that it does not exceed authorized possession limits. This information must be submitted quarterly to the Radiation Safety Officer.

7. Maintain adequate records of disposal of radioactive material. This information must be submitted quarterly to the Radiation Safety Officer.

8. Ensure that personnel wear assigned personnel monitoring, if required.

9. Ensure that adequate facilities, equipment and calibrated instruments are provided.

10. Ensure that *all* sources of radiation are secured against unauthorized use or removal from their place of storage or use.

11. Comply with all responsibilities of an individual radiation worker.

12. Properly label and store all sources of radiation.

13. Notify the Radiation Safety Officer when a woman under his/her supervision is known to be pregnant.

14. Provide for decontamination of facilities or equipment which may become contaminated as a result of procedures involving unsealed sources of radiation.

15. Perform required contamination and radiation surveys and maintain adequate records of the results of all required surveys or tests.

16. Notify the Radiation Safety Officer at least 30 days in advance of intentions to vacate or relinquish possession of an area where radioactive materials are used or have been used or stored. An exit survey of the area(s) will be performed by the Radiation Safety Officer. If necessary, the Principal Investigator shall decontaminate the premises to the contamination and radiation levels specified in Chapter 1, Part 16 of the New York State Sanitary Code. The Radiation Safety Officer will verify that decontamination has been satisfactorily performed.

Each individual ***Radiation Worker*** who may use radioactive material or who may use equipment that emits radiation is responsible for complying with the procedures and precautions contained in this document; with those established by a protocol for use of the material or equipment; and with applicable regulations of Federal, State and Local agencies.

Specific responsibilities of the radiation worker are:

1. Read the Radiation Safety Manual prior to using any radioactive material and/or radiation producing equipment and comply with the general requirements for safe handling of radioactive material and/or radiation producing equipment.

2. Be familiar with and follow specific instructions for radiation protection provided by the Principal Investigator and the Radiation Safety Officer.

3. Keep radiation exposure to the lowest practical levels by wearing all protective devices and using all appropriate handling equipment.

4. Wear appropriate radiation monitoring devices, if required.

5. Monitor the area and all equipment prior to, during and after the use of unsealed sources of radioactive material.

6. <u>DO NOT</u> smoke(chew), eat, drink or apply cosmetics in areas approved for use of radioactive material.

7. Maintain clean work habits and conduct good house-keeping practices.

8. Label, when required, all containers, sinks in which radioactive material may be deposited, refrigerators and freezers containing radioactive materials.

9. Report suspected spills or contamination immediately to the Radiation Safety Officer.

10. Conduct decontamination procedures under the direction of the Radiation Safety Officer and Principal Investigator.

11. Report promptly to the Radiation Safety Officer any condition which may lead to or cause a violation of any regulation under the conditions of our license or unnecessary personnel exposure to radiation or radioactive material.

12. Become familiar with appropriate responses in the event of any occurrence or malfunction that may involve personnel exposure to radiation or radioactive materials.

PREGNANT WORKERS

Each woman working with radiation sources should notify her supervisor and the Radiation Safety Officer that she is pregnant as soon as she becomes aware of the pregnancy. The informational booklet, "Instruction Concerning Prenatal Radiation Exposure" published by the US Nuclear Regulatory Commission, is available through the Radiation Safety Officer on request.

PERSONNEL TRAINING PROGRAM

ALL individuals shall be given initial training by the Radiation Safety Officer or his designee prior to the use of radioactive materials and/or radiation producing equipment. It shall not be assumed that safety instruction has been adequately covered by prior training at other institutions. Even experienced professionals will need instruction in our local policies, procedures and conditions of our license.

Personnel shall be instructed:

1. before assuming duties with, or in the vicinity of, radioactive materials and/or radiation producing equipment.

2. during annual refresher training.

3. whenever there is a significant change in duties, regulations, or the terms of our license or radiation producing equipment permit.

Initial training shall cover the following topics:

1. Basic units of activity, exposure, dose and dose equivalent.

2. The concepts of linear energy transfer, quality factor, RAD and REM.

3. Modes of decay and interactions with matter.

4. External radiation protection - principles of time, distance, shielding and contamination control.

6. Biological effects from radiation exposure. The NRC Regulatory Guide 8.29, “Instructions Concerning Risks from Occupational Exposure” is discussed.

5. Instrumentation - Use of GM survey meters and associated meters, as applicable.

6. Personnel monitoring - Use of whole body TLDs and extremity dosimetry, when personnel monitoring is required, location of exposure history reports, bioassay results. Advise individuals as to the radiation exposure reports which workers must be given or may request.

7. Applicable regulations and license/permit conditions.

8. Areas where radioactive materials and/or radiation producing equipment is used or stored.

9. Potential hazards associated with radioactive materials and/or radiation producing equipment in each area where the individuals will work.

10. Appropriate radiation safety procedures.

11. Licensee's in-house work rules.

12. Each individual's obligation to report unsafe conditions to the Radiation Safety Officer.

13. Appropriate response to emergencies or unsafe conditions.

14. Worker's right to be informed of occupational radiation exposure and bioassay results.

15. Location where the licensee has posted or made available notices, copies of pertinent regulations, and copies of pertinent licenses and license conditions (including applications and applicable correspondence), as required by New York State regulations.

PERSONNEL DOSIMETRY

Personnel dosimetry (whole body TLD badges and TLD ring badges) is issued to individuals based on the type and amount of radioactive materials being used as indicated on the Principal Investigator's application for authorization to use radioactive materials. Most personnel dosimeters cannot detect the presence of low energy beta particles such as those emitted by ^{3}H, ^{14}C, and ^{35}S. If you use only these isotopes, you will not be issued a dosimeter.

The whole body TLD badges and the TLD rings are generally exchanged on a quarterly basis. The Radiation Safety Officer maintains a file of radiation exposure history reports in the Office of Environmental Health and Safety. If you are interested in finding out the amount of exposure you have received, contact the Radiation Safety Officer. ***It is each individuals responsibility to be aware of the exposure you have received.***

General Guidelines

1. Wear your whole body TLD badge on the frontal part of the chest or waist. Your ring badge should be worn on the inside of your protective gloves with the label turned toward the palm of your hand. Double glove your badged hand to prevent contamination of your ring badge due to a tear in the glove.

2. Clip the whole body TLD to your lab coat so that the front stays upright and faces away from your body. Never allow clothing such as lapels, ties, buttons, etc. to shield the front of the badge.

3. **A badge is to be worn only by the person to whom it is issued.** You should only wear University badges for University related exposures. If you are required to travel to other facilities contact the RSO for consultation and possibly an issuance of a second badge.

4. Badges should be protected against damage from heat, moisture, and pressure.

5. Badges must not be worn during non-occupational exposure, such as during procedures involving medical or dental x-rays.

6. Badges must be stored in areas remote from radioactive material work areas and radioactive material storage areas. Dosimetry badges shall ***NOT*** be taken home.

7. Notify the RSO if; 1) an individual no longer needs personnel monitoring, 2) an individual not presently monitored requires badging, 3) an individual loses or damages his/her dosimetry.

RADIATION PRODUCING EQUIPMENT

INTRODUCTION

All radiation producing equipment at the University must be registered with the New York State Department of Health. The Radiation Safety Officer must be informed whenever any radiation producing equipment enters or leaves the University.

The radiation safety problems associated with analytical x-ray equipment are unique. Most analytical x-ray equipment has extremely intense, narrow, low energy beams. Dose rates on the order of 4 x 10^5 R/min. at the port of ordinary diffraction tubes are not unusual. Exposure to the primary beam for even a few seconds can cause severe and permanent damage to the area of the body exposed.

Typical potentials for diffraction tubes are 25-50 kVp and 25-100 kVp for those used in fluorescent analysis. The upper limit for the energy of x-ray photons is, therefore 50-100 keV. The x-ray continuum is assumed to extend from 5-100 keV, with an intensity maximum in the 20-30 keV range. Superimposed on this continuum is the characteristic spectrum of the anode. Energies involved here range from 5.4-17.5 keV.

Radiation monitoring problems associated with x-ray diffraction and x-ray fluorescence units are various and difficult. Hazardous radiation may come from the following sources:

1. The primary beam;
2. Leakage or scatter of the primary beam through cracks in ill fitting or defective equipment;
3. Penetration of the primary beam through the x-ray tube housing, shutters, or diffraction apparatus;
4. Secondary emission from the sample or other material exposed to the primary beam;
5. Diffraction x-rays;
6. Radiation generated by rectifiers in the high voltage power supply.

The leakage or scatter of the primary beam through apertures in ill fitting or defective equipment can produce very high intensity beams of small and irregular cross-section. Diffraction beams also tend to be small and irregular in shape. They may be directed at almost any angle with respect to the primary beam. Exposure rates on the order of 80 R/hr for short periods of time are not unusual.

The hazard resulting from penetration of the useful beam through shutters or the x-ray tube housing is slight in well designed equipment. Adequate shielding can be readily obtained at the energies commonly used for diffraction and fluorescent analysis. Radiation surveys prior to initial use of analytical x-ray equipment and at frequent intervals afterward are essential to detect any of the situations discussed above.

Radiation from the high voltage power supply may be a result of gassy rectifiers. The effective potential is twice the potential applied to the x-ray tube, and the radiation produced is extremely penetrating. This condition may arise at any time, therefore shielding the assembly that contains the rectifiers and semi-annual radiation leakage surveys are strongly recommended.

ADDITIONAL RESPONSIBILITIES (radiation equipment users)

DEPARTMENT CHAIR is responsible for ensuring compliance with this section. At their discretion, alternate means of assuring an equivalent level of safety may be required for programmatic reasons. Such variations will be documented and referred to the Office of Environmental Health and Safety. Department chair is responsible for ensuring that all new Principal Investigators are informed of local procedures and policies for ordering/purchasing any type of radiation producing equipment.

PRINCIPAL INVESTIGATORS are responsible for direct implementation of this section. Specifically, principal investigators and/or faculty will:

1. Ensure that operational procedures pertaining to radiation safety are established and executed;

2. Provide adequate instruction in safety practices for all personnel who work with or near analytical x-ray equipment;

3. Approve all individuals who are to operate any analytical x-ray equipment. Such approval will be based on the individual's competence as an operator, and the extent of radiation safety training that he/she has received;

4. Review and approve (after consultation with the Radiation Safety Officer) all modifications to x-ray equipment that may significantly alter the safety status of the facility or the unit itself;

5. Shall ensure that all protective devices such as interlocks, safety switches, fume hoods, filters and trapping devices for radioactive gases are maintained in good repair and proper operating condition. Perform operational tests of all radiation safety devices at regular intervals. Records of these tests should be maintained and kept on file.

USERS are responsible for complying with all provisions of this section.

RADIATION SAFETY OFFICER is responsible for assisting in the implementation of this section. Specifically, the Radiation Safety Officer will:

1. Assist the Principal Investigator in establishing operational procedures pertaining to radiation safety;

2. Review the Principal Investigator's plan for providing adequate instruction in radiation safety procedures to personnel who work with or near analytical x-ray equipment. These instructions may be devised as orientations, formal written procedures or formal training sessions;

3. Assist the Principal Investigator in reviewing and approving modifications pertaining to the radiation safety program;

4. Audit for compliance with this guide and report to the Department Chair.

AREA REQUIREMENTS

1. <u>Radiation Area</u> - Any area accessible to personnel in which there exists radiation at such level that the whole body, head and trunk, active blood-forming organs, gonads, or lenses of the eyes could receive in any one hour a dose in excess of 5 mrems, or in any 5 consecutive days a dose in excess of 100 mrem. Each radiation area should be posted with a sign or signs bearing the radiation symbol and the words, "CAUTION: RADIATION AREA".

2. <u>Controlled Area or Restricted</u> - Any area in which the dose equivalent received by individuals may exceed 500 mrem in any year, but does not exceed the levels that would require it to be designated a radiation area. Each controlled area should be identified by an appropriate and easily recognizable sign posted at each entrance.

3. <u>Noncontrolled Area or Unrestricted</u> - Any area to which access is not controlled for purposes of radiation protection.

OPERATIONAL SAFEGUARDS

General

The following recommendations are applicable to all x-ray systems:

1. Each facility or laboratory containing analytical x-ray equipment should have a listing of authorized operators posted conspicuously at the entrance to the facility or laboratory.

2. A warning light or device of fail safe design labeled with the words "X-Ray ON" or other words having similar meaning shall be located near any switch which energizes an x-ray tube.

3. A fail-safe light or indicator on a conspicuous location near the radiation source housing shall be used to indicate when the x-ray tube is on or the port of the radioactive source is open.

4. A label bearing the conventional radiation symbol and the words, **CAUTION: THIS EQUIPMENT PRODUCES X-RAYS WHEN ENERGIZED--TO BE OPERATED ONLY BY QUALIFIED PERSONNEL,** or other words having similar meaning shall be attached near any switch which energizes an x-ray tube.

5. Systems that contain an x-ray tube shall be equipped with an interlock that shuts off the tube if it is removed from the radiation source housing or if the housing is disassembled.

6. A label bearing the conventional radiation symbol and the words, **CAUTION: THIS EQUIPMENT CONTAINS RADIOACTIVE MATERIAL--TO BE OPERATED ONLY BY QUALIFIED PERSONNEL,** or words having similar meaning shall be attached to the control panel of each x-ray system that contains a radioactive source.

7. A label bearing the conventional radiation symbol and a statement of (a) the type of radioactive material, and (b) the activity in curies or millicuries, and (c) the date of measurement of the activity shall be attached to the radiation source housing of each x-ray system that contains a radioactive source.

8. Normal operation procedures and alignment procedures shall be documented by the manufacturer of the x-ray system, or by the Principal Investigator if the radiation source housing and x-ray accessory apparatus are not compatible components supplied by the same manufacturer.

9. All safety devices (shutters, warning lights, etc.) should be tested quarterly by users to insure their proper operation. Records of these tests shall be maintained.

10. Any attempt to alter safety devices either temporarily or on a permanent basis shall be approved by the Principal Investigator and the Radiation Safety Officer. A warning of the alteration shall be <u>conspicuously</u> posted. Radiation protection surveys shall be performed after <u>each</u> alteration of safety devices. Records of these surveys shall be maintained.

11. Radiation protection surveys should be conducted in the immediate vicinity of the x-ray apparatus by qualified personnel on a routine basis. These surveys may be performed by the operator under the guidance of the Radiation Safety Officer.

12. Operators of analytical x-ray equipment will be required to use personnel monitoring devices provided by the Radiation Safety Officer.

Requirements for enclosed beam x-ray systems in addition to the general requirements.

1. The radiation source, sample, detector, and analyzing crystal (if used) shall be enclosed in a chamber or coupled chambers that cannot be entered by any part of the body during normal operation.

2. The inherent shielding of the chamber walls shall be sufficient to limit the dose rate in all regions 5 cm. from its outer surface to 0.25 mrem/h during normal operation.

3. The sample chamber closure shall be interlocked with the x-ray tube high voltage supply or a shutter in the primary beam so that no x-ray beam can enter the sample chamber while it is open unless the interlock has been consciously and deliberately defeated. This interlock shall be of fail-safe design.

4. If there is more than one port in the radiation source housing or more than one radiation source, all requirements above must be satisfied for <u>**each**</u> port in every source housing associated with the system.

Requirements for open beam x-ray systems in addition to the general requirements. (Systems that do not meet the requirements of an enclosed beam system)

1. All shutters will be provided with a “SHUTTER OPEN” indication of fail-safe design.

2. Radiation levels external to the x-ray tube housing with all shutters closed shall not exceed 2.5 mrem/h as measured 5 cm from the surface of the housing within which an x-ray tube is operating at full rated power at maximum rated accelerating potential.

3. Each port of the radiation source housing shall be provided with a beam shutter interlocked with the x-ray accessory apparatus coupling, or collimator, in such a way that the port will be open only when the coupling or collimator is in place. Shutters at unused ports shall be secured to prevent casual opening.

4. A guard or interlock which prevents entry of any part of the body into the primary beam should be utilized.

5. A system barrier will be provided so that the dose equivalent received by individuals in the controlled area is as low as reasonably achievable, but does not exceed 5 mrem in any one (1) hour or 100 mrem in any five (5) consecutive days.

RADIOACTIVE SEALED SOURCE POLICIES

Radioactive sources are stored in Chemistry B-56 or in the Accelerator Laboratory. A list of radioactive sources, owned by the University, is available from the Radiation Safety Officer. These sources must not leave their storage locations unless authorization is given by the Radiation Safety Officer. Contact the Radiation Safety Officer to check-out/check-in radioactive sources.

University policies:

1. All personnel using radioactive sealed sources must be trained in the hazards, safety precautions, and proper use of the radioactive material.

2. Always store sources in their original storage containers in a designated locked cabinet or room. Do not store sources in the vicinity of dosimeter storage locations. Do not use sealed sources in noncontrolled areas without specific approval of the Radiation Safety Officer.

3. Be aware of external and surface dose rates. Use time-distance-shielding techniques whenever possible. Use remote handling devices where appropriate. This should be considered for even small check sources to reduce finger exposure.

4. Whenever handling or removing a source from its container, look for abnormalities. If in doubt about the condition of a source, return it to storage and contact the Radiation Safety Officer immediately to perform a leak test.

5. Do not leave any source that produces more than 5 mrem/h at 12 inches unattended unless specific arrangements are made with the Radiation Safety Officer.

6. Wear a radiation dosimeter when using sources that can produce whole body dose rates in excess of 2 mrem/h.

7. Have a radiation survey instrument immediately available when radiation levels in excess or 2 mrem/h are being produced.

8. Maintain a use log for those sources that can produce significant personnel exposure (>5 mrem/hr. at 12 inches). This log should contain sufficient detail so that any operation with the source can be reconstructed.

9. Be aware of and follow the usage restrictions specified on the Application Approval Form.

Leak Test Requirements

Each sealed source, containing radioactive material other than H-3, with a half-life greater than 30 days and in any form other than a gas shall be tested for leakage as follows:

Beta/Gamma Emitters: (source must contain greater than 100 μCi)

1. Prior to initial use;

2. Every six months;

3. Damaged or suspected leakage;

4. Leak test is not required if the source is designated in storage and not being used routinely with the requirement that;

    a. The source shall be tested prior to any use,

    b. the source shall be tested prior to transfer to another person unless it has been tested within the last six months.

Alpha Emitters: (Source must contain greater than 10 μCi)

1. Prior to initial use;

2. Every three months for alpha sources;

3. Damaged or suspected leakage.

AUTHORIZATION TO USE RADIOACTIVE MATERIALS

The University is issued a broad license through the New York State Department of Health, Bureau of Environmental Radiation Protection, which allows the possession, use, transfer, and disposal of radioactive materials. All Principal Investigators using radioactive materials must be authorized to do so by the Radiation Safety Committee. Authorizations are granted to qualified individuals who are the Principal Investigators of research projects and/or responsible for supervising radioactive materials use by associate users or students in their laboratory.

All laboratory areas where radioactive material will be used must be approved by the Radiation Safety Committee.

An individual requesting approval to use radioactive materials must submit the following information to the Radiation Safety Officer.

1. “Application for Use of Radioactive Materials” (see App. E)

2. “Request for Personnel Monitoring” and “Statement of Agreement, Training, and Experience” (see App. E) - For each individual that intends to use radioactive materials.

3. Submit the protocols for each intended use of radioactive materials.

4. “Intent and Ability to Fund form”, (see App. E)

All applications for the use of radioactive materials are reviewed by the Radiation Safety Officer for regulatory and license compliance. All applications for the use of radioactive materials are forwarded to the Radiation Safety Committee for review. If the application is approved, the Radiation Safety Officer drafts a memorandum to the Principal Investigator establishing what isotopes he/she has been approved for by the Committee and what the maximum activity limits are for each isotope. Any stipulations that the Committee has mandated will be included in this memorandum. A radioactive materials license certificate is issued and must be posted in the laboratory. The Radiation Safety Officer oversees all preliminary lab setups, postings, and initial radiation safety training.

All Principal Investigators approved to use radioactive material must complete an annual radiation safety review/renewal application sent out by the Radiation Safety Officer.

The Radiation Safety Committee has establish a Radioactive Materials Use Suspension Process Policy (see App. F). This Policy is to ensure that all Principal Investigators are aware of the University’s intent to ensure a safe environment relating to radioactive materials. Each non-compliance issue is handled on a case by case basis, but generally will follow the corrective actions established in this policy.

ORDERING/RECEIVING RADIOACTIVE MATERIALS

Prior to the purchase of any quantity of radioactive materials, an individual must have the approval of the Radiation Safety Committee for that specific isotope, amount of activity, and general chemical form to be ordered. NO QUANTITY OF RADIOACTIVE MATERIAL IS EXEMPT FROM THIS PROCEDURE.

All radioisotope orders must be approved by the Radiation Safety Officer. (This includes samples, regardless of whether or not there is a charge for them). Quantities ordered may not allow the lab to exceed its authorized possession limits. Principal Investigators must maintain a record of all radioactive material in their possession.

To Order:

1. Fill out purchase requisition including; isotope type, chemical form, quantity (μCi), vendor, and principal investigator's name.

2. The requisition should be signed by an authorized principal investigator or his/her approved designee.

3. Take the requisition to the Radiation Safety Officer for review and approval. The requisition must have the RSO's stamp and signature for purchasing to process the order.

4. Take or fax to purchasing.

Receiving radioactive materials:

Radioisotopes are delivered to the College of Arts and Science Stores in the Chemistry building. The RSO or the RSO's designee will check-in, survey, and inspect all radioactive material packages prior to them being released to the laboratories. The laboratory personnel are responsible for inspecting and surveying inside the primary packaging during initial opening. If the internal container is damaged or contamination found, contact the RSO immediately.

If the RSO or his designee is not available to open, inspect and survey delivered packages the laboratory will use the following procedure for opening packages.

1. Put on gloves to prevent hand contamination.

2. Visually inspect the package for any sign of damage (i.e., wetness, crushed). If damage is noted, stop and notify the Radiation Safety Officer as soon as possible.

3. Measure exposure rate at 3 feet (or 1 m.) from the package surface and record the reading. If it is higher than usual (>0.5 mr), stop and notify the Radiation Safety Officer as soon as possible.

4. Open the package while following precautionary steps:

   a. Open the outer package (following manufacture's directions, if supplied) and remove packing slip.

   b. Open the inner package and verify that contents agree with those on the packing slip. Compare requisition, packing slip and label on container.

   c. Check the integrity of the final source container (i.e., inspect for breakage of seals or vials, loss of liquid, or discoloration of packaging material)

5. If there is any reason to suspect contamination, wipe external surface of source container and remove wipe to low background area. Assay the wipe and record the amount of removable radioactivity (i.e., dpm/100 square centimeters, etc.). Check wipe with a thin window GM survey meter, and take precautions against the spread of contamination as necessary.

6. Monitor the packing material and packages for contamination before discarding.

   a. If contaminated, treat as radioactive waste.

   b. If not contaminated, obliterate radiation labels before discarding in regular trash.

7. Maintain records of the results of checking each package.

RADIATION PROTECTION PROCEDURES

Each Worker should be aware of the methods or procedures that can be used to reduce his/her radiation exposure when working with radiation sources. To limit external radiation exposure, you can reduce the time spent using radioactive materials, increase the distance between you and the radiation source, and/or use shielding between the radiation source and the body.

For prevention of internal exposure, wear the appropriate protective clothing (lab coats, gloves, etc.), perform work in a fume hood, minimize the amount of radioactive materials handled, and make sure the radioactive materials are properly contained. The policies outlined below should be followed whenever you use radioactive materials.

POLICIES FOR SAFE USE OF RADIOACTIVE MATERIALS

1. Prior to performing operations with quantities of radioactive material which may produce significant external or internal exposure, attention shall be given by the user to precautionary measures including the use of remote handling devices, hoods, shielding, etc. The Radiation Safety Officer must be consulted before beginning any new use of radioactive material.

2. There shall be no eating, drinking, (chewing), applying of cosmetics, or preparation of food in any location where unsealed sources of radioactive materials are used or stored.

3. Smoking is prohibited in locations where unsealed sources of radioactive materials are used or stored.

4. Do not store food, drink, or personal effects with radioactive material.

5. MOUTH PIPETTING IS PROHIBITED in radioactive material work areas.

6. Segregate pipetting devices used with radioactive materials from those used with non-radioactive solutions.

7. Lab coats and disposable gloves shall be worn during operations involving the handling of unsealed sources of radioactive material. The lab coat and gloves should be removed before leaving the laboratory. Care must be taken such that other items (i.e., pens, pencils, notebooks, door knobs, telephones, etc.) are <u>not</u> handled with gloves used during work with radioactive materials.

8. Work which may result in contamination of work surfaces shall be done over plastic-backed absorbent paper. Trays made of impervious materials (i.e., stainless steel, porcelain-coated, etc.) and lined with absorbent paper provide excellent work arrangements to help prevent the spread of contamination.

9. Work surfaces should be monitored prior to, during and after working with unsealed sources of radioactive material. Personnel should monitor

themselves including hands, body, hair, shoes, and clothing. If contamination is present, decontamination shall be completed <u>before</u> leaving the area. Hands should be washed before leaving the laboratory.

10. Where there has been a spill of radioactive material involving personnel contamination the Radiation Safety Officers shall be informed <u>immediately</u>.

11. Objects and equipment that may have been contaminated with radioactive material shall be surveyed by the Radiation Safety Officer and demonstrated to be free of contamination prior to their removal from a laboratory, or transferred to other laboratories, repair shops, surplus, etc.

12. Radioactive materials areas must be **<u>locked</u>** when unattended unless all radioactive sources are otherwise secured. When Laboratories with radioactive material are unoccupied they shall be locked.

13. Label all containers and equipment that comes in contact with radioactive materials. Beakers, flasks, and test tubes used transiently in lab procedures do not need to be labeled.

14. Issued personnel monitoring devices should be worn at all times when in areas where radioactive materials are used or stored. These devices should be worn as prescribed by the Radiation Safety Officer. Personnel monitoring devices should be stored in designated low background areas when they are not being worn to monitor occupational exposures. They should <u>not</u> be shared with another individual.

15. Dispose of radioactive waste only in the manner designated by the Radiation Safety Officer and maintain records as instructed.

16. Always transport radioactive material in shielded containers.

17. Radioiodinations shall be performed only in hoods designated by the Radiation Safety Officer. Currently, there is one designated hood available. See the RSO for details.

<u>RADIOACTIVE MATERIALS SURVEYS</u>

Routine surveys of radioactive materials use/work, storage and disposal areas are required by the New York State Department of Health as part of the conditions of the University's radioactive materials license. Maintaining adequate records of laboratory surveys is also required by the Department of Health. These surveys are ***mandatory***, and are considered part of the conditions of your laboratory's authorization to use radioactive materials as granted by the Radiation Safety Committee. Failure to perform routine laboratory surveys or keep records of surveys could result in suspension or loss of your authorization to use radioactive materials.

Types of surveys

Laboratory surveys are performed to identify radioactive contamination that is present and to prevent its spread. Basically, there are two (2) types of laboratory surveys you will be expected to perform. There is a portable instrument, direct frisk survey and a wipe test survey using a liquid scintillation counter or portable instrument.

Geiger (GM) counters with thin window pancake probes can be used to detect beta emitting isotopes with energies above 70 KeV. This includes ^{14}C, ^{35}S, and ^{32}P. Geiger (GM) counters with thin-window end-window probes should only be used to detect high energy beta emitting isotopes (i.e., ^{32}P). Low energy beta emitting isotopes, such as ^{3}H, can only be detected using a liquid scintillation counter. Low energy gamma emitting isotopes, such as ^{125}I, can be detected with a sodium iodide (NaI) probe, gamma counting system or liquid scintillation counter.

Before using any portable survey instrument, you should be familiar with its proper operation. For example, because of their low energies, ^{14}C and ^{35}S may be difficult to detect with an end-window GM meter. Unless you are reasonably certain of the area contaminated, or there is a large quantity of contamination present, you may overlook an area contaminated with either of these isotopes if you use only an end-window GM meter for your survey.

To perform a survey using a portable instrument, scan the area with the instrument's probe. Hold the probe close to the surface and move the probe ***slowly***. Watch the instrument's meter response while you are moving the probe. Listening to the audible "clicks" can be very helpful while performing this type of survey. The probe should remain within 1/2" of the surface but not touch the surface to minimize potential contamination of the probe. If you find a "hot" area, it should be decontaminated to the lowest levels possible **before** you leave the lab at the end of the day.

The "wipe test" is the most common procedure to detect removable contamination. A piece of filter paper (Whitman 4.25 cm Qualitative circles or the equivalent) is moistened with 70% isopropanol or another appropriate solvent and then wiped over an area of approximately 100 cm^2 (16" x 1" S-shape wipe or 4" x 4" box wipe). The wipe samples are analyzed in different ways. For beta emitting isotopes, particularly those with energies below 200 keV (^{3}H, ^{14}C, ^{35}S), a liquid scintillation counter should be used. Wipe samples for x-ray or gamma emitters (^{125}I) should be analyzed using a gamma counting system or sodium iodide (NaI) probe. High energy beta emitters (^{32}P) may be counted with either the GM meter or liquid scintillation counter. Results must be recorded in dpm whenever counting with the liquid scintillation counter. To convert your cpm results to dpm:

$$dpm = \frac{\text{gross counts - bkg. counts}}{\text{efficiency}}$$

EFFICIENCIES: (For Beckman unit located in BIO-341)

^{3}H - determine by use of calibration standard
^{14}C - determine by use of calibration standard

GM Meter:

44-7 (End window type)		44-9 (Pancake type)	
P-32	S-35	P-32	S-35
~20%	~5%	~50%	~10%

Frequency of Surveys / Recording Surveys

Surveys for radiation and radioactive contamination must be performed after each use of radioactive materials. The purpose of this survey is to identify any contamination present and to prevent its spread. This survey does not need to be recorded.

A formal survey for contamination and radiation levels must be performed on a weekly basis in all radioactive material waste storage areas and work areas where greater than 200 µCi of isotope is used for any procedure. If you use only ^{32}P, you need only perform direct frisk surveys with a GM meter as long as the background counts are $\leq$100 cpm. Records of these area surveys and wipe tests should be kept on file in each laboratory.

***ALL* RADIOACTIVE MATERIAL WORK, USE, WASTE, AND STORAGE AREAS MUST HAVE MONTHLY WIPE TESTS, REGARDLESS OF THE ISOTOPE(S) HANDLED IN THESE AREAS.** This includes all centrifuges in which radioactive samples are spun, incubators where tagged cells are held, Cold Room equipment and bench areas you use for radioactive materials work, waste containers and their storage areas (such as cabinets), and refrigerators and freezers where radioactive materials are stored. Monthly contamination surveys will be done using the liquid scintillation counter regardless of radioisotope being used. Along with wipe tests the monthly survey should also include a direct frisk of all lab bench areas. A designated technician in each lab will perform monthly surveys in the lab areas. A copy of the monthly surveys should be sent to the Radiation Safety Officer after completion. If a copy of your labs previous months surveys is not received by the first Friday of each month, no radioactive material orders will be approved.

If you are not actively using radioactive materials, but have them stored in your lab, monthly wipe test of the storage areas is required. The results should be kept on record in your lab. Copies of these recorded surveys should also be sent to the Radiation Safety Officer.

Removable Contamination Limits

The University's policy is to keep contamination levels **as low as reasonably achievable**. Items or areas that could come in contact with skin or personal clothing should be decontaminated until undetectable by a wipe test. When measurable contamination is found on skin or personal clothing, notify the Radiation Safety Officer immediately.

For removable contamination greater than 1000 dpm/100 cm^2, the item(s) or area(s) must be cleaned up to the lowest practical levels within one work day. Removable contamination levels greater than 2000 dpm/100 cm^2 must be decontaminated immediately. These area survey results should be documented on the survey maps along with corrective action. The results of subsequent surveys during and after decontamination should be recorded and kept on file. If necessary a remarks sheet should be included with the survey to explain the circumstances surrounding the incident.

Items that could be used in other noncontrolled areas (e.g., centrifuges to be sent out for repair) must be cleaned until NO contamination is detectable by a wipe test or direct frisk. RSO must authorize the release of **ALL** items for unrestricted use.

Labs that are "Inactive" are not required to perform and submit monthly radiation contamination surveys. These labs are required to file quarterly reports, in response to the Radiation Safety Officer, and are subject to period inspection.

A lab is considered "inactive" when:

- No handling of radioactive material of any kind (stock material, experiments, or waste) has occurred for a period of greater than two (2) months.
- The PI in the lab has submitted a written statement to the Radiation Safety Officer stating such.

The PI is required to inform the Radiation Safety Officer when work with radioactive material recommences. A request for an order of radioactive material will automatically reactivate the lab.

The Radiation Safety Committee may choose to review labs that remain inactive for greater than six months to verify the continued need for radioactive material use approval.

RADIOACTIVE WASTE DISPOSAL

Current instructions for the disposal of each category of radioactive waste is available through the Radiation Safety Officer. These instructions should be carefully followed. In view of the recent problems with shallow-land burial sites, volume and waste reduction methods should be implemented in all laboratories. Important steps in volume reduction are to segregate radioactive from nonradioactive waste, to hold short-lived radioactive waste for decay-in-storage, and to release certain authorized materials in the sanitary sewer.

The following recommendations should be implemented for waste reduction:

1. Separate "exempt" scintillation vials from other scintillation vials. "Exempt" vials refer to scintillation media containing less than 0.05 µCi/g of ^{3}H or ^{14}C.

2. Be sure only radioactive waste is placed in the designated container(s) supplied by the Radiation Safety Officer. Do a wipe survey or a portable instrument survey of the item if you are in doubt. If only a small portion of an item is radioactive (ex. bench paper), dispose of only the contaminated portion as radioactive waste.

3. **Decay-in-storage.** Waste containing short-lived isotopes (<90 day half-life) can be stored until decay (minimum of ten half-lives). If you choose to decay waste, designated storage areas should be assigned and the areas posted in each lab. Prior to unrestricted disposal of the decayed waste the Radiation Safety Officer will survey the waste and approve its disposal.

4. **Sanitary sewer system disposal.** Only laboratories that have received specific permission from the Radiation Safety Officer can dispose of radioactive material via the sanitary sewer system. Radioactive material must be: 1) readily soluble in water; or 2) biological material that is readily dispersible in water. Regulations governing any other toxic or hazardous property of these materials must be considered prior to authorized disposal.

    a. Authorized laboratories may dispose of the following licensed material without regard to its radioactivity. (Certain cocktails may be subject to hazardous waste regulations)

        1) 0.05 µCi or less of ^{3}H or ^{14}C per gram of medium, used for liquid scintillation counting; and

        2) 0.05 µCi or less of ^{3}H or ^{14}C per gram of animal tissue averaged over the weight of the entire animal; provided however, tissue may not be disposed of under this condition in a manner that would permit its use either as food for humans or as animal feed.

    b. Individual laboratory limits for sanitary sewer disposal are as follows:

Isotope	Activity (mCi / month)
^{3}H	3000
^{14}C	1600
^{35}S	2000
^{32}P	600
^{33}P	160

^{36}Cl	160
All others combined	160

General Guidance

1. All radioactivity labels must be defaced or removed from containers and packages prior to disposal in in-house waste.

2. All long-lived waste (>90 day half-life) should be transfer to the Radiation Safety Officer for disposal. Records containing waste type, activity and volume must be submitted upon transfer.

3. High energy beta emitter (i.e., P-32) waste should be stored in plastic waste cans and behind Plexiglas shielding.

4. All waste bags should be closed and labeled as soon as the bag is full. Waste cans should not be overflowing. If the waste bag has a hole in it put a second bag around it prior to placing in storage. Use designated labels on waste bags and include the following information; type of isotope, approximate activity, date of closing bag, date of decay.

5. Radioactive waste should not be stored under sinks.

6. Radioactive waste should not be stored with other hazardous chemicals.

BIOASSAY REQUIREMENTS

Radioiodine

Radioiodine exposure is monitored by thyroid bioassay. Thyroid monitoring is implemented whenever an investigator uses radioiodine in quantities which exceed those specified in Table 1 of Regulatory Guide 8.20 (Applications of Bioassay for I-125 and I-131). The Radiation Safety Officer shall be notified of Radioiodine use so that arrangements for a thyroid bioassay within 48-72 hours of use can be made, if necessary.

Tritium

Routine bioassay is necessary when quantities of tritium processed by an individual at any one time or the total amounts processed per month exceed those specified in Table 1 of Regulatory Guide 8.32 (Criteria for Establishing a Tritium Bioassay Program). The Radiation Safety Officer shall be notified whenever using large quantities of Tritium (>1mCi).

Spill Procedures

All spills of radioactive material should be cleaned up as soon as possible. The responsibility for cleaning up the spill rests with the individual(s) working in the area involved and/or responsible for the spill. Under no circumstance should an untrained person attempt to examine or clean up a spill of radioactive materials. If assistance is needed, contact the Radiation Safety Officer.

Major Incidents/Spills - Spills that cannot be contained or cleaned up readily (in excess of 200 µCi of any beta emitting isotope and any quantity of ^{125}I), widespread contamination, any personnel contamination or clothing contamination, ingestion of radioactive materials, contamination found outside controlled areas, overexposure to radiation.

Minor Incidents/Spills - Spills involving less than 200 µCi of any beta emitting isotope in a controlled area.

The following are general guidelines to be followed when dealing with spills involving radioactive material:

Minor Incidents / Spills

1. **NOTIFY:** *Notify persons in the area that a spill has occurred.*

2. **PREVENT THE SPREAD:** *Place absorbents such as paper towels or tissues over the spill to prevent its spread. If the material is a powdered solid, cover the spill area with a barrier such as a beaker, drip tray, or damp towels.*

3. **CLEAN UP:** *Use disposable gloves and remote handling tongs. Carefully fold the absorbent paper and pad. Insert into a plastic bag and dispose in the radioactive waste container. Also insert into the plastic bag all other contaminated materials such as contaminated gloves.*

4. **SURVEY:** *Check the areas around the spill with a GM meter. If Tritium was spilled take wipe surveys of the area and count in the liquid scintillation counter. Always frisk yourself and your clothing to ensure you are not contaminated.*

5. **REPORT:** *Document and report incident to the Radiation Safety Officer.*

Major Incidents / Spills

1. **CLEAR THE AREA:** *Notify all persons not involved in the spill to vacate the room.*

2. **CLOSE THE ROOM:** *If not personally contaminated, leave the room and lock the door(s) to prevent entry.*

3. **CALL FOR HELP:** *Notify the Radiation Safety Officer immediately. Call the Environmental Health and Safety Office during normal working hours or the RSO's home phone during off hours (See Emergency phone list).*

4. **MINIMIZE YOUR EXPOSURE:** *Minimize your exposure to surface contamination, radiation, and airborne contamination. Use rubber gloves, plastic shoe covers, and/or filter mask as necessary. Move to the edge of the spill area. Get contaminated personnel out of the area as soon as possible. Assemble a nearby safe or clean area. Begin monitoring and decontamination of affected personnel. Remove contaminated clothing at once, flush contaminated skin with luke warm soap and water. Place all contaminated items in radioactive waste containers.*

5. **PREVENT THE SPREAD:** *Place absorbents such as paper towels or tissues over the spill to prevent its spread. If the material is a powdered solid, cover the spill area with a barrier such as a beaker, drip tray, or damp towels.*

6. **SHIELD THE SOURCE:** *If possible, the spill and/or other sources should be shielded, but only if it can be done without further contamination or without significantly increasing your radiation exposure.*

7. **PERSONNEL DECONTAMINATION:** *Contaminated clothing should be removed. If the spill is on the skin, flush thoroughly and then wash with mild soap and lukewarm water.*

Supplemental actions

1. **DECONTAMINATE THE AFFECTED AREA.** *Provide adequate protection and supplies for personnel involved with the clean up. Begin at the periphery and work toward the center of the contaminated area. Cover clean areas with plastic or paper to prevent recontamination. Place all contaminated items in radioactive waste containers.*

2. **MONITOR THE PROGRESS OF THE DECONTAMINATION.** *Use the appropriate survey techniques (wipe tests, direct frisk survey of the area with a GM meter, etc.). Verify that all personnel and equipment are properly decontaminated before allowing them in clean areas. Document all surveys taken and maintain a record of them. Write down a summary of the incident and attach to the survey map(s) if necessary. Submit to the Radiation Safety Officer.*

APPENDIX

Appendix Contents

UNITS

Erg	Unit of energy or work; approximate energy needed to lift a 1 mg weight 1 cm at sea level.
eV	Electron volt. The amount of kinetic energy acquired when an electron falls through a potential difference of 1 volt. 1 eV = 1.6 X 10^{-12} ergs.
keV	1,000 eV = 10^3 eV = 1.6 X 10^{-9} ergs.
MeV	10^6 eV = 10^3 keV = 1.6 X 10^{-6} ergs.
SI	Abbreviation for the International System of Units
Curie (Ci) /	The special unit of radioactivity specifying quantity. SI unit - Becquerel
Becquerel (Bq)	1 Ci = 3.7 x 10^{10} transformations/sec. 1 Bq = 1 transformation/sec.
Roentgen (R)	Unit of radiation **exposure**. A measure of the ionization produced in air by X or γ radiation with energies up to 3 MeV. It is the sum of the electrical charges on all ions of one sign produced in air when all electrons liberated by photons in a volume of air are completely stopped in air, divided by the mass of the air in the volume element. 1 R = 2.58 x 10^{-4} coulombs/kg of air 1 R = 2.08 x 10^9 ion pairs in 1 cc of air at STP
RAD / Gray (Gy)	Unit of **R**adiation ***A***bsorbed ***D***ose equal to 100 ergs per gram in any material. SI unit - Gray 1 RAD = 100 ergs/gm = 0.01 J/kg 1 Gray = 100 RAD
REM / Sievert (Sv)	***R***oentgen ***E***quivalent ***M***an; Unit of radiation dose equivalent. The unit to express human biological doses as a result of exposures to one or many types of ionizing radiation. SI unit - Sievert 1 Sievert = 100 REM
Quality Factor (QF)	The linear energy transfer (LET) dependent factor by which absorbed doses are multiplied to obtain (for radiation protection purposes) a quantity that expresses, on a common scale for all ionizing radiation, the effectiveness of the absorbed dose. (QF values- β,χ,γ = 1; n,ρ = 10; α = 20)

ISOTOPES COMMONLY USED IN RESEARCH LABORATORIES

Beta Emitting Isotopes:

^{3}H

Energy = 19 keV β
Half-life ($t_{1/2}$) = 12.28 years
Biological $t_{1/2}$ = 10 days

Critical Organ for Uptake - Body Water
Detection Instrument - LSC
Range in air = 4.7 mm (0.19 in.)

Disposal: Segregate from shorter $t_{1/2}$ waste. Contact RSO for disposal.

Millicurie quantities of tritium do not present an external exposure hazard because the low energy betas emitted cannot penetrate the outer dead layer of skin. Tritium cannot be detected by using a GM meter; wipe tests must be performed to detect its presence. Because of its low beta energy, no shielding is required when using tritium, but contamination control measures are required. Some tritium compounds readily penetrate gloves and skin. Handle these compounds remotely, wearing two pairs of gloves and change the outer layer at least every 20 minutes.

^{14}C

Energy = 156 keV β
Half-life ($t_{1/2}$) = 5730 years
Biological $t_{1/2} \approx$ 10 days

Critical Organ for Uptake - Bone or Fat
Detection Instrument - LSC
Range in air = 8.6 inches = 21.8 cm

Disposal: Segregate from shorter $t_{1/2}$ waste. Contact RSO for disposal.

Millicurie quantities of ^{14}C do not present a significant external exposure hazard because the low energy betas emitted barely penetrate the outer dead layer of skin. ^{14}C is not easily detected with a GM meter (only use as a gross determination), wipe tests are advised to detect its presence. No shielding is required when using ^{14}C, but contamination control measures are required. Some ^{14}C compounds readily penetrate gloves and skin. Handle these compounds remotely, wearing two pairs of gloves and change the outer layer frequently. Special caution should be observed when handling ^{14}C-labeled halogenated acids. These compounds can be incorporated in the skin and deliver very high local dose commitments.

^{35}S

Energy = 167 keV β
Half-life ($t_{1/2}$) = 87.4 days
Biological $t_{1/2}$ = 90 days

Critical Organ for uptake - Whole Body
Detection Instrument - GM meter or LSC
Range in air = 24 cm (9.6 in.)

Disposal: Segregate from longer $t_{1/2}$ waste. Decay waste for ten $t_{1/2}$ (2.5 years). Contact RSO to inspect and survey waste prior to unrestricted disposal.

Beta Emitting Isotopes (con't):

^{35}S con't

Millicurie quantities of ^{35}S do not present a significant external exposure hazard since the low energy emissions barely penetrate the outer dead layer of skin. It is not easily detectable with a GM meter (only use as a gross determination), wipe tests are advised to detect its presence. Contamination control measures must be taken when using ^{35}S, shielding is not required. Some ^{35}S compounds, including methionine, generate volatile fractions particularly during lyophilization or incubation. Use of these compounds should be done in a ventilation hood.

^{32}P

Energy = 1.71 MeV β	Critical Organ for Uptake - Bone, Lung, LLI
Half-life ($t_{1/2}$) = 14.29 days	
Biological $t_{1/2} \approx$ 19 days	Range in air = 6 m (20 ft.)
Detection Instrument - GM meter or LSC	Range in Plexiglas = 8 mm(0.3 in.)

Disposal: Segregate from longer $t_{1/2}$ waste. Decay waste for ten $t_{1/2}$ (143 days ≈ 5 months). Contact RSO to inspect and survey waste prior to unrestricted disposal.

The high energy beta emissions can present a substantial skin dose hazard. Use of at least 1/4 inch Plexiglas shielding is required when using ^{32}P in experimental procedures. Laboratory personnel using ^{32}P are required to wear a whole body badge along with a ring badge. ^{32}P is easily detected with a GM meter. Prior to using millicurie quantities of ^{32}P contact RSO for additional precautions.

^{33}P

Energy = 249 keV β	Critical Organ for Uptake - Bone, Lung, LLI
Half-life ($t_{1/2}$) = 25.4 days	
Biological $t_{1/2} \approx$ 19 days	Range in air = 46 cm (18 in.)
Detection Instrument - GM meter or LSC	

Disposal: Segregate from longer $t_{1/2}$ waste. Decay waste for ten $t_{1/2}$ (254 days ≈ 8.5 months). Contact RSO to inspect and survey waste prior to unrestricted disposal.

Millicurie quantities of ^{33}P do not present a significant external exposure hazard since the low energy emissions barely penetrate the outer dead layer of skin. Handle ^{33}P compounds that are potentially volatile or in powder form in a ventilation hood. Shielding is not required.

Beta Emitting Isotopes (con't):

^{45}Ca	Energy = 257 keV β	Critical Organ for Uptake - Bone
	Half-life ($t_{1/2}$) = 163 days	Detection Instrument - GM meter or LSC
	Biological $t_{1/2}$ = 1.8 x 10^4 days	Range in Air = 48 cm (19 in.)

Disposal: Segregate from shorter $t_{1/2}$ waste. Contact RSO for disposal.

Millicurie quantities do not present a significant external exposure hazard because the low energy betas emitted barely penetrate gloves and the outer dead layer of skin. Due to ^{45}Ca long biological $t_{1/2}$ work should be performed in a ventilation hood.

Gamma Emitting Isotopes:

^{125}I	Energy = 35 keV γ	Critical Organ for Uptake - Thyroid
	Half-life ($t_{1/2}$) = 60.14 days	Detection Instrument - NaI crystal
	Biological $t_{1/2}$ = 138 days	

Disposal: Segregate from longer $t_{1/2}$ waste. Decay waste for ten $t_{1/2}$ (602 days ≈ 1.7 years). Contact RSO to inspect and survey waste <u>prior</u> to unrestricted disposal.

^{125}I is not readily detected with a GM meter because of its extremely low energy. A low energy gamma probe equipped with a NaI crystal is the instrument of choice for detecting the presence of ^{125}I. Wipe tests can also be done to detect ^{125}I and counted in a gamma counter. The major radiation protection concern when using ^{125}I is thyroid dose. Solutions of radioiodine are extremely volatile; the tagged iodine readily dissociates to form a free species. This free radioiodine is released as a "puff" when the container is opened. Laboratory personnel planning on using ^{125}I should contact the RSO prior to its use to discuss the required precautions. Thyroid monitoring to determine personal uptake may be necessary.

^{51}Cr	Energy = 320 keV γ	Critical Organ for Uptake - LLI, Lung
	Half-life ($t_{1/2}$) = 27.7 days	Detection Instrument - GM meter, LSC, NaI
	Biological $t_{1/2}$ = 616 days	

Disposal: Segregate from longer $t_{1/2}$ waste. Decay waste for ten $t_{1/2}$ (277 days ≈ 10 months). Contact RSO to inspect and survey waste <u>prior</u> to unrestricted disposal.

Wipe tests, counted in a gamma counter, can be done to detect ^{51}Cr. Use shielding to minimize exposure while handling ^{51}Cr. NaI detector is the detector of choice for ^{51}Cr. ^{51}Cr should be used in a ventilation hood due to its relatively long Biological $t_{1/2}$.

OCCUPATIONAL DOSE LIMITS

ADULTS: 18 years of age or older

Annual Limits - Whole Body (which ever is more limiting)

1. The total effective dose equivalent being equal to 5 REM; or

2. The sum of the deep dose equivalent and the committed dose equivalent to any organ or tissue other than the lens of the eye being equal to 50 REM.

Annual Limits - Lens of Eye, Skin, Extremities

1. An eye dose equivalent of 15 REM, and

2. A shallow dose equivalent of 50 REM to the skin or to any extremity.

Minors: Less than 18 years of age

1. 10% of the annual occupational dose limits specified for adult workers.

Embryo / Fetus:

1. Dose to a declared pregnant woman shall not exceed 500 MREM during the entire gestation period and work conditions shall be adjusted to avoid a monthly exposure rate of more than 50 MREM.

Non-Occupational Limits

Individual Members of the Public:

1. Shall not exceed 2 MREM in any one hour and 100 MREM per year.

RADIATION PRODUCING EQUIPMENT PROCEDURES

NICOLET R3M - CHEMISTRY 337

The x-ray generator is located inside the main body of the diffractometer module. It supplies voltage and current to the x-ray tube filament. Both the voltage and current are adjustable. Over-voltage and over-current indicators are included and are preset for maximum voltage and current levels. They provide a visible warning and turn off the generator automatically at any attempt to increase the voltage of current beyond their preset levels. The tube cooling system uses and open-flow, filtered tap water system.

The x-ray tube is mounted on the base of the goniometer. Worm gears allow for 3-D alignment. The x-ray tube also pivots horizontally about the focal spot for take off angle changes.

Visible warning is provided by indicator lights. The “X-Ray” light is ON when the generator is turned on. The “BEAM” indicator lights when the shutter is OPEN.

If the “X-Ray” indicator is inoperative, the generator shuts down automatically. Failure of the “BEAM” indicator incapacitates the beam shutter.

The incident beam collimator is furnished with adjustable pinhole inserts so that beam size may be adjusted to operator needs. For adjustment procedures such as the tube alignment, a rate meter is available and continuously displays counts per second. ONLY QUALIFIED OPERATORS SHOULD BE PERFORMING ALIGNMENT PROCEDURES OF ANY TYPE ON THIS UNIT.

A hinged, transparent cover encloses the entire system. It provides a temperature stable environment for data collection, and prevents the operator from inadvertent exposure of his/her appendages to ionizing radiation by placing them in the x-ray beam pathway.

The side access panel is the only panel that is not interlocked or permanently installed to prevent inadvertent entry while the shutter is open. This panel shall not be opened while the shutter is opened unless specifically authorized by the Radiation Safety Officer. A sticker shall be attached to the panel and all individuals must be trained on this practice.

SUMMARY OF SAFETY DEVICES ON NOCOLET R3M

1. Generator ON light indicates the high voltage is ON.

2. “X-Ray” light indicates generator is ON. Generator shuts down automatically if the light is inoperable.

3. “BEAM” light indicates shutter is OPEN. Failure of indicator incapacitates beam shutter.

4. Over-voltage and over-current indicators will automatically turn generator OFF if preset maximums are exceeded.

5. Transparent cover prevents inadvertent radiation exposure to operator.

6. The front panel is interlocked to prevent opening the cover while the shutter is open. This feature is of "Fail Safe" design. The shutter will automatically close if the cover is opened inadvertently while the shutter is open. This device should not routinely be used to close the shutter during normal operations. The key to override this interlock shall be maintained by the Principal Investigator for the research project. The Radiation Safety Officer shall be informed if this or any interlock must be overridden for any reason.

ION IMPLANTER - Chemistry B-57

The following procedures are to assist the operator after completion of the training sessions conducted by the Accelerator Engineer or a designated instructor. The operator may then run the unit under the supervision of a qualified operator until certified by the Accelerator Engineer.

The prospective operator will carefully read these procedures and sign the appropriate page in the Implanter Log. Questions relating to procedure or problems arising with the Ion Implanter will be directed to the appropriate technical specialist or the Accelerator Engineer. BE SURE TO ASK ANY QUESTIONS YOU MAY HAVE BEFORE YOU BEGIN OPERATING THE UNIT.

Under NO circumstances will an individual operate the Ion Implanter without completing the necessary series of instruction OR without supervision until he/she is certified by the Accelerator Engineer as being fully qualified to do so. This means thorough familiarization with these procedures and demonstrated capability to operate the Ion Implanter, along with demonstrated ability in rebuilding the “911” source, including charging of the oven.

Precautions:

1. Only qualified individuals are permitted to operate this unit. If you have questions regarding the safe operation of this unit, consult with the Principal Investigator overseeing your work BEFORE you begin your experiment.

2. Operate the unit in a positive mode using approved gases, only.

3. There is more hazard from high voltage than radiation while the ion implanter is operating, but X-Rays can be produced by the high voltage rectifier. The metal panels on the sides of the unit effectively shield any x-rays that may be produced during the normal operation of the unit. DO NOT REMOVE THE METAL SIDE PANELS.

4. Whenever preparing to work on the source assure that all switches securing the Implanter are in the appropriate positions and the key is removed from the console and is on your person while removing the source. (NOTE: ELECTRONICS ARE LEFT ENERGIZED TO READ THERMOCOUPLE GAUGES). Assure that there is no residual high voltage by shorting the terminal with the provided shorting bar.

5. Whenever the doors to the high voltage area are open, be sure that the key is removed from the console.

6. Valves <u>MUST</u> be operated in the sequence indicated in the procedure.

7. Fill in the necessary information in the machine Operating Log when you begin operation of the unit.

Initial Conditions:

1. Check chamber valve positions prior to turning on the system electronics. Check system pressures to assure the Implanter is in the 10^{-5} torr region **or below prior to operation**.

2. Do not operate any system valves related to high vacuum when the related thermocouple gauge reads **greater than 150 microns pressure**.

3. Do not secure the diffusion pump of the associated forepump when shutting down the Implanter following a run.

4. Check position of the following controls **prior to** operation of Implanter:

    a. Anode voltage - Fully counterclockwise.

    b. Filament voltage - Fully counterclockwise.

    c. Oven current - Fully counterclockwise.

    d. Source Magnet - Fully counterclockwise

    e. Gas valve - Fully counterclockwise. (New heater controlled valve).

    f. Accelerating voltage - Fully counterclockwise.

    g. High voltage switches - OFF.

    h. Extractor switch - OFF.

    i.. Ion source magnet - OFF.

    j. Beam sweep amplifier - ON.

    k. Oscillator power - ON.

    l. Chamber valve control box - OFF.

    m. Quadruple control - OFF.

    n. “503” oscilloscope - OFF.

    o. All cabinet doors CLOSED.

    p. Check oil level on turbopump.

Preparing for Implantation

1. Select the proper ion source and prepare it for mounting on the Implanter. (See section on source.) If the source is already mounted, omit section 2.

2. Mount source on Implanter as follows:

   a. Assure the Implanter is properly secured.

   b. Open door #1 and use shorting bar to discharge any residual high voltage.

   c. Remove plastic from obstructing the work area.

   d. Close valve between accelerator section and source section and source section. **Make sure this valve is properly closed.**

   e. Open vacuum relief valve on roughing bypass pipe and let system up to atmospheric pressure. If possible, use dry nitrogen as it will appreciably shorten pump down time after changing the source.

   f. Remove gas line from source.

   g. Remove filament and oven electrical leads.

   h. Holding the source with one hand, release the thumbscrews, and carefully remove it from the Implanter. Remove the “O” ring.

   i.. Place the source in the desiccator cabinet below the bench. Label the source “REMOVED”.

   j. Place the “O” ring on the source and insert in the Implanter. Insure that the source is seated properly, and tighten the two (2) thumbscrews to hold the source in place.

   k. Recheck the continuity of the filament and oven on the source.

   l. Reconnect the oven filament electrical leads.

   m. Reconnect the gas line to the source.

   n. Attach the roughing exhaust line to the valve on the roughing bypass pipe. Check that this valve is OPEN.

   o. Open door #2 and close the switch operating the valve between the diffusion pump and the forepump. Open the valve to the roughing line.

p. Observe the thermocouple gauge on the machine console (Electronics switch ON) as the source area is roughed out. When the pressure reads less than 150 microns, return to door #1 and close the valve on the bypass pipe. Move to door #2 and close the roughing line valve. Open the valve to the foreline on the diffusion pump.

q. Return to door #1 and open the valve between the accelerator section and the source. Remove the roughing line and slide toward the gas minifold.

r. Replace the plastic and securely close door #1.

s. Open door #3, remove plastic sheet. Connect roughing line to the manifold pump down valve.

t. Assure that all gas bottle valves are turned OFF, then OPEN the pump down valve. Go to door #2 and operate the valves in the same sequence as stated in paragraph o. Observe the thermocouple gauge,

u. When the pressure is **less than 100 microns**, CLOSE the manifold pump down valve. Return to door #2 and CLOSE the roughing line valve and OPEN the foreline valve to the diffusion pump.

v. Return to door #3, select the gas to be used as the carrier gas or implant ion, and OPEN the valve while observing the pressure gauge. CLOSE the valve on the bottle. Replace the plastic, close and secure door #3.

w. Return to the console, the Implanter is ready for operation when the system pressure is less than 2 X 10-5 torr.

3. At the console:

a. Check all pressure gauges to insure that all pressures are in the appropriate operating range:

Turbopump thermocouple gauge less than 75 microns.

Diffusion forepump thermocouple gauge less than 75 microns.

Neutral trap ion gauge less than 2 X 10-5 torr.

NOTE: ELECTRONICS MUST BE ON TO CHECK THERMOCOUPLE GAUGES.

b. Turn on motor generator. Insert key into switch.

c. While the motor generator is warming up, turn on high voltage switch and "503" oscilloscope.

d. When trace appears on both oscilloscopes, turn ON current integrator, then turn ON key switch. The safety light will go OUT. Record start reading in log. Turn ON extractor and ion source magnet switches. Observe extractor current reading.

e. Advance filament in steps of three (3) to five (5) amperes. (Turn clockwise.) Observe filament meter and the ion gauge pressure. Allow pressure to recover between increasing steps of filament current until a current of approximately 20 amperes is reached (or full adjustment of control.

f. Advance the anode voltage (clockwise) to full scale reading.

g. Adjust magnet control to mid-region of adjustment.

h. Adjust mass meter for the mass of the carrier gas in the manifold.

i.. Inject carrier gas into source by slowly opening the gas valve while observing the following:

   1) Neutral trap ion gauge

   2) Anode current

   3) Anode voltage

   4) Source oscilloscope

   Maintain the gas pressure **below 2 X 10^{-5} torr**. Operating in the lower pressure region produces a cleaner beam for implantation.

j. When "arc is struck", the anode voltage will drop, anode current will increase, and a peak will appear on the ion source oscilloscope. Adjust gain step on the ion source for the best observable peak. Increase anode voltage to increase beam current.

k. If using a solid in the oven for a source of implantation ions, re-adjust the mass meter for the ion mass desired. Advance oven current control slowly until a satisfactory ion peak appears on the source oscilloscope.

l. Turn ON accelerating voltage supply and turn ON quadrupole power supply. These can be turned on earlier without damage to the equipment, if desired.

m. Advance accelerating voltage adjustment to the desired implantation.

n. Adjust the beam sweep amplitude control to mid-scale. There will be a double peak on the "503" oscilloscope.

o. Select the appropriate chamber line for implantation - either 1 or 2.

p. Using the control marked "Align on Pins", adjust the double peak to the center region of the "503" oscilloscope.

q. While maintaining the double peak in the center of the "503" oscilloscope, adjust the following for the best appearing symmetrical peaks:

    1) Mass meter

    2) Extraction voltage

    3) Anode voltage

    4) Ion source magnet

    5) Both quadrupole adjustments

    6) Vertical centering control

   These controls will interact with each other and the sequence will need to be repeated several times.

r. Open valve to target area insuring that the chamber region is properly prepared, i.e. sealed and roughed down appropriately to system levels. The implant area down stream from the valve is the experimenter's responsibility. He/she must provide appropriate target holders, cold cans, implant chamber (if other than mounted cross), isolation for current integrator connections, secondary electron suppression, etc., as well as appropriate vacuum levels of the target region. Targets to verify beam uniformity and general alignment before implantation are included in this responsibility.

University at Albany, SUNY
Department of Environmental Health and Safety

RADIOACTIVE MATERIAL ORDER / RECEIPT LOG

Principal Investigator ___________________________

Date Ordered	Isotope	Chemical Form	Vendor	Date Rec'd	P.O. #	Inspected for Damage (v)	Contaminated		Labels Defaced (v)
							Yes (v)	No (v)	

University at Albany, SUNY
Department of Environmental Health and Safety

RADIOACTIVE MATERIALS INVENTORY

Principal Investigator ________________________ **lot#**_______

Isotope __________ **Original Activity** _______ **µCi** **Chemical Form** ________

Date Rec'd ______________ **Date Disposed** ________________

Date	User	Amount Used (µCi)	Balance (µCi)

University at Albany, SUNY
Department of Environmental Health and Safety

RADIOACTIVE MATERIAL DRY WASTE DISPOSAL LOG

Principal Investigator ____________________________ Waste Can/Bag # _______________

Date	Amount Disposed (µCi)	Isotope

Date Closed ________________ Expected Release Date (10 half-lives) ___________________
(^{32}P - 5 months, ^{35}S - 2.5 yrs.)

Date Inspected and Released by RSO __________________

University at Albany, SUNY
Department of Environmental Health and Safety

RADIOACTIVE MATERIAL SANITARY SEWER DISPOSAL LOG

Principal Investigator ___________________________ Quarter/Year ___________________

Date	Amount Disposed (µCi)	Isotope

Monthly Totals:

1st month of Qtr.	Isotope					
	Total Activity					

2nd month of Qtr.	Isotope					
	Total Activity					

3rd month of Qtr.	Isotope					
	Total Activity					

Quarterly Totals:

Isotope					
Total Activity					

University at Albany, SUNY
Department of Environmental Health and Safety

INCIDENT RECORD

This sheet should be used to document any incidents relating to radioactive materials. Incidents are defined as: spills; skin or clothing contamination; damaged packages received; injuries; etc. Please attach copies of all surveys performed. Notify the Radiation Safety Officer as soon as possible.

Principal Investigator ____________________ Date ______________ Time _____________

Location of Incident _____________________ Isotope Involved _______________________

Personnel Involved ____________________________ ______________________________

____________________________ ______________________________

____________________________ ______________________________

COMMENTS:

SEALED SOURCE LEAK TEST PROCEDURE

1. A list of all sources requiring leak testing is maintained by the Radiation Safety Officer.

2. If testing high-activity sources, set out a survey meter, preferably with a speaker, so you can monitor you exposure rate.

3. Prepare a separate wipe sample for each source. A cotton swab, injection prep pad, filter paper, or tissue paper is suitable. Number each wipe so you will know fro which source it is to be used. Samples should be taken as follows:

   a. For small sealed sources, it is easiest to wipe the entire accessible surface area. Pay particular attention to seams and joints. However, do not wipe the port of beta applicators.

   b. For larger sealed sources and devices (irradiators), take the wipe near the radiation port and on the activating mechanism.

   c. If you are testing radium sources, they should also be checked for radon leakage. This can be done by submerging the source in a vial of fine-grained charcoal or cotton for a day. Then remove the source and analyze the adsorbent sample as described below. A survey should be done to be sure the sources are adequately shielded during the leak-test period.

4. The will be analyzed as follows:

   a. Select a suitable detector that is sufficiently sensitive to detect 0.005 microcuries. For beta sources, a proportional flow counter, liquid scintillation counter, or thin-end-window GM survey may be appropriate. For gamma sources, a crystal with a ratemeter or scaler or a GM survey meter may be appropriate.

   b. Assay a check source that has the same isotope as the sealed source and whose activity is certified by the supplier. If one is not available, it will be necessary to use a certified check source with a different isotope that has a similar spectrum in order to estimate the detection efficiency of the analyzer used to assay the wipe samples.

   c. Assay the wipe sample. It must be in the same geometry relative to the detector as was the certified check source.

d. Calculated the estimated activity in microcuries on the wipe sample.

e. Continue same analysis procedure for all wipe samples.

f. If the wipe sample activity is 0.005 microcuries or greater the source must be withdrawn from use to be repaired or disposed of and notify the NYS Department of Health.

g. Record the wipe sample result on the list of sources. Sign and date the list.

DEFINITIONS

As Low As Reasonably Achievable

Making every reasonable effort to maintain exposures to radiation as far below the dose limits as is practical, consistent with the purpose for which the licensed or registered activity is undertaken, taking into account the state of technology, the economics of improvements in relation to state of technology, the economic of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to utilization of nuclear energy and licensed or registered sources of radiation in the public interest.

Controlled area

A specific area in which exposure of personnel to radiation or radioactive materials is controlled and which is under the supervision of a person who has knowledge of the appropriate radiation protection practices, including pertinent regulations, and who has responsibility for applying them.

Enclosed Beam X-Ray System

An enclosed beam x-ray system is one in which all possible x-ray paths are fully enclosed according to the "Operational Safeguards" section.

Fail-Safe Design

One in which any failure of indicator or safety components that can be reasonably anticipated cause the equipment to fail in a mode such that the personnel are safe from exposure to radiation. For example: (a) If a light indicating "X-RAY ON" fails, the production of x-rays will be prevented, and (b) if a shutter status indicator fails, the shutter shall close.

Leakage Radiation

All radiation coming from within the source or tube housing except the useful beam.

Normal Operation

Operation under conditions suitable for collecting data as required by a manufacturer of the x-ray system.

Open Beam X-Ray System

An x-ray system that does not comply with the requirements outlined for an enclosed beam system.

Primary Beam

Ionizing radiation from an x-ray tube anode or radioisotope which is allowed to pass by a direct path through an aperture in the radiation source housing for use in conducting measurements.

Radiation Source Housing

That portion of an x-ray system that contains the x-ray tube or radioactive isotope.

Scattered Radiation

Radiation that has been diviated in direction during passage through matter. A decrease in the energy of the particular radiation may accompany this.

System Barrier

That portion of an x-ray installation which clearly defines the transition from a controlled area to a radiation area and provides such shielding as may be required to limit the dose rate in the controlled area during normal operation.

X-ray Accessory Apparatus

Any portion of an x-ray installation which is external to the radiation source housing and into which an x-ray beam is directed for making x-ray measurements or for other uses.

X-ray System

Apparatus for generating and using radiation, including all x-ray accessory apparatus.

University at Albany, SUNY

Radioactive Material/Radiation Producing Equipment Suspension Process

Issued by: The University's Radiation Safety Committee

Reason for Policy: This Policy is to ensure that all Principal Investigators are aware of the University's intent to ensure a safe environment relating to radioactive materials and radiation producing equipment.

Categories: Reportable incident, Regulatory Code/License non-compliance, University policy non-compliance, Lab inspections.

Authority Base: The University's Radiation Safety Officer (RSO) shall have full authority to ensure radioactive materials (RAM) and radiation producing equipment are controlled in accordance with all local, state and federal regulatory requirements. The Radiation Safety Officer shall have the authority to disapprove a Principal Investigator's (PI) request to purchase or use radioactive material or radiation producing equipment during conditions of non-compliance. The Radiation Safety Officer shall have the authority to temporarily suspend a Principal Investigator's use of radioactive material or radiation producing equipment pending formal review by the University's Radiation Safety Committee. The University's Radiation Safety Committee (RSC), under the authority of this University's President, shall retain sole authority to permanently suspend any Principal Investigator's ability to use and possess radioactive material and/or radiation producing equipment.

Corrective Actions: 1st offense - Probationary status (verbal warning with immediate corrective action), 2nd offense - Temporary suspension (with re-training, suspended use), 3rd offense - Temporary suspension with a remediation letter submitted by the Principal Investigator to the Radiation Safety Committee stating corrective action and acknowledgment of possible permanent suspension, 4th offense - suspension.

Escalation: RSO >> Principal Investigator >> Department Chair >> Dean >> Radiation Safety Committee >> President

Inspections:

Lab Inspections: Laboratory inspections will be Satisfactory or Unsatisfactory. 1st UNSAT - Verbal warning with immediate corrective actions. 2nd UNSAT - Probationary status (letter to PI, carbon to the Department Chair). 3rd UNSAT - Temporary suspension with upgrade training (letter to PI, Department Chair, Radiation Safety Committee Chair, carbon to the

Dean). 4th UNSAT - RSO will recommend a review and suspension to the Radiation Safety Committee.

Automatic unsatisfactory lab inspection: 1) Contamination found in areas not designated for RAM (floors, non-designated benches, desks, doors, etc.), 2) Excessive RAM not properly stored, 3) Food in any areas designated for RAM use (refrig., benches, sinks, etc.), 4) Observation of improper laboratory techniques (mouth pipetting, improper or no safety equipment, etc.).

University policy non-compliance: This category may include various issues covered under code regulations and law. Issues covered will include, but are not limited to:

1. Surveys completed correctly, on time, and delivered to the RSO as per RSO policy.
2. Quarterly Inventories completed correctly and delivered to the RSO as specified by request memo sent to PI.
3. Untrained/unauthorized personnel working with radioactive materials or radiation producing equipment.
4. Continued improper practice of policies and procedures specified per the Local, State and Federal policies and regulations.
5. Timely completion of Principal Investigators license and permit renewals.

Reportable incident, Regulatory Code/License non-compliance: New York State Department of Health inspections. All situations in this category will be reviewing by the Radiation Safety Committee. The Radiation Safety Committee will determine corrective action.

Submitted by: ______________________________________
Scott A. Richards, RSO

Reviewed by: ______________________________________
Vincent T. Franconere, Dir. of EH & S

Approved by: ______________________________________
Dr. Hassaram Bakhru, Chair RSC