Policy
for

Radiation Safety Program

REVISION

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1 PURPOSE

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

- To provide for the protection of the Albany NanoTech Complex (ANC) population and of the general public against radiation hazards associated with:

  a) Acquisition, use, transportation, and disposal of radioactive materials (RAM); and

  b) Use of machines and equipment that emit either ionizing and/or non-ionizing radiation.

- To provide for NY CREATES compliance with applicable regulations of federal, state, and local agencies.

2 SCOPE

This program applies to all site employees, tenants, contractors, and students who use and work with radiation producing equipment, materials, and/or sources.

3 DEFINITIONS & ACRONYMS

3.1 **ANC** – Albany NanoTech Complex

3.2 **Bioassay** – A chemical experiment used to measure the effects of a substance on a living organism. Radionuclides are used to track these substances.

3.3 **Dosimetry** – The measurement of ionizing radiation.

3.4 **GM Meter** – Geiger-Muller survey meter to measure ionizing radiation.

3.5 **mrem** – 1000 mrem = 1 rem

3.6 **NYSDOH** – New York State Department of Health

3.7 **RAD** – Radiation Absorbed Dose, measures the amount of radiation energy transferred to some mass of material, typically humans.

3.8 **Radionuclides** – An atom with an unstable nucleus that undergoes radioactive decay and emits ionizing radiation. Also referred to as radioactive isotopes or radioisotopes.

3.9 **REM** – Roentgen Equivalent Man, a unit that relates the dose of any radiation to the biological effect of that dose.

3.10 **TLD** – The radiation badge (Thermoluminescent Dosimeter [TLD]) is the main method for determining to how much radiation a worker is exposed.

4 DELEGATION OF AUTHORITY

4.1 Radiation Safety Officer (RSO)

The Radiation Safety Officer (RSO) 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.

The RSO has the following duties and responsibilities:

1) Keep current and maintain the file for the site radiation equipment registrations and radioactive materials license.

2) Ensure that the Radioactive Materials License is amended, when necessary, prior to any changes in facilities, equipment, policies, procedures, RAM, possession limits, and personnel, as specified in the license.

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

4) Review protocols and applications for authorized use of RAM and/or radiation producing equipment under the license/permit and aid in completing such applications.

5) Be responsible for supplying advice and assistance on all matters involving the use of RAM and other radiation sources.

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

7) Prescribe special conditions that will be required during the proposed use of RAM such as requirements for bioassays, physical examinations of users, and special monitoring procedures.

8) Review the entire radiation safety program at least annually to determine that all activities are being conducted safely and in accordance with NYSDOH regulations and the conditions of the RAM license.

9) 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.

10) Be responsible for the procurement, receipt, delivery, and shipment of all RAM coming to or leaving the site.

11) Maintain records on procurement and receipt of RAM and of radiation producing equipment.

12) Be responsible for the supervision of radioactive waste disposal. The RSO shall provide current information concerning all aspects of radioactive waste disposal.

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

14) Maintain an inventory of all radionuclides on site and limiting the quantities of radionuclides to the amounts authorized.

15) Instruct individuals on proper procedures for handling RAM and radiation producing equipment. Be available for consultation on laboratory design, shielding, and other radiation exposure control methods.

16) Oversee the completion of periodic radiation surveys and wipe tests in laboratories and storage areas. The RSO may conduct periodic surveys of work areas to supplement and audit routine monitoring by authorized users.

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

18) Be responsible for calibration of monitoring and survey instruments under their supervision.

19) Conduct training and otherwise instruct personnel in the proper procedures before they are allowed to use RAM and/or radiation producing equipment.

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

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

22) Perform duties of RSO as listed in State Sanitary Code Chapter 1, Part 16.

23) Direct and prescribe decontamination procedures. Aid with decontamination in emergency cases and maintain an adequate inventory of decontamination supplies.

4.2 Principal Investigator / Tool Owner (PI / TO)

The Principal Investigator / Tool Owner (PI/TO) is responsible for the protection of personnel listed on their protocol, prevention of contamination of the site, and compliance with all rules and regulations of federal, state, local, and site 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 RAM and radiation producing equipment.

3) Conduct and document initial training for all personnel on laboratory and tool-specific policies, and safety procedures. Conduct and document annual refresher training of these policies and procedures highlighting new regulatory changes and site policy changes.

4) Notify the RSO of changes which may affect radiation safety requirements, such as (but not limited to): changes in personnel; changes in room use; changes in experimental technique; and problems in the receipt, use, or disposal of RAM/radiation producing equipment.

5) Limit participation in the use of RAM and/or radiation producing equipment to persons with appropriate training.

6) Maintain adequate inventory of the number of unsealed sources of RAM possessed and ensure that it does not exceed authorized possession limits. This information must be submitted quarterly to the RSO.

7) Maintain adequate records of disposal of RAM. This information must be submitted quarterly to the RSO.

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 individual radiation users.

12) Properly label and store all sources of radiation.

13) Notify the RSO when an individual under their supervision is known to be pregnant and the individual permits that information to be disclosed.

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 RSO at least 30 days in advance of intentions to vacate or relinquish possession of an area where RAM is used or has been used or stored. The RSO will perform an exit survey of the area(s). If necessary, the PI shall decontaminate the premises to the contamination and radiation levels specified in Chapter 1, Part 16, of the New York State Sanitary Code. The RSO will verify that decontamination has been satisfactorily performed.

4.3 Radiation User

Each individual Radiation User who may use RAM 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 user are:

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

2) Be familiar with and follow specific instructions for radiation protection provided by the PI or TO and the RSO.

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 RAM.

6) DO NOT smoke (or chew), eat, drink, or apply cosmetics in areas approved for use of RAM.

7) Maintain clean work habits and conduct good housekeeping practices.

8) Label, when required, all containers, sinks in which RAM may be deposited, refrigerators, and freezers containing RAM.

9) Report suspected spills or contamination immediately to Security and the RSO.

10) Conduct decontamination procedures under the direction of the RSO and PI/TO.

11) Report promptly to the RSO any condition which may lead to or cause a violation of any regulation under the conditions of our Radioactive Materials license or unnecessary personnel exposure to radiation or RAM.

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

5 ASSOCIATED DOCUMENTS

5.1 **EHS-00016-F1** – New Equipment and Process Change Checklist

5.2 **EHS-00066-F1** – Maintenance Ionizing Radiation Survey Form

5.3 **EHS-00066-F2** – Radiation Device Inventory

5.4 **EHS-00066-F3** – Radiation Survey Sheet

5.5 **EHS-00066-F6** – Radiation Sealed Source Inventory

6 PREGNANT WORKERS

Any individual working with radiation sources that becomes aware they are pregnant are strongly encouraged to notify their company's Human Resources Department who will work with the RSO, as appropriate, to ensure any necessary additional control measures are taken. Contact your specific employer Human Resource group for specific policies. Educational information related to prenatal radiation exposure is available through the RSO on request.

This information will be kept in strict confidence.

7 PERSONNEL TRAINING PROGRAM

ALL individuals shall be given initial training by the RSO, or a designee, prior to the use of RAM and/or radiation producing equipment, where a possible exposure exists. 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 the local policies, procedures, and conditions of the site Radioactive Materials license.

7.1 Personnel to be instructed:

- Individuals who work in the lab or cleanroom areas where radiation sources are present shall receive radiation awareness training during Cleanroom or Lab Safety training prior to accessing these areas.
- Individuals who perform maintenance on radiation producing equipment (i.e., removing shielding, adjusting X-ray beams, etc.) shall receive additional radiation equipment safety training.
- Individuals who work with RAM shall receive Radiation Safety training, as well as annual refresher training.

7.2 Radiation Safety 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.

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

6) Instrumentation – Use of GM survey meters and associated meters, as applicable.

7) Personnel Monitoring – Use of whole body TLDs and extremity dosimetry, when personnel monitoring is required, location of exposure history reports, bioassay results. Advise individuals about radiation exposure reports which workers must be given or may request.

8) Applicable regulations and license/permit conditions.

9) Areas where RAM and/or radiation producing equipment is used or stored.

10) Potential hazards associated with RAM and/or radiation producing equipment in each area where the individuals will work.

11) Appropriate radiation safety procedures.

12) Licensee’s in-house work rules.

13) Each individual’s obligation to report unsafe conditions to the RSO.

14) Appropriate response to emergencies, spills, or unsafe conditions.

15) Worker’s right to be informed of occupational radiation exposure and bioassay results.

16) 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.

8 PERSONNEL DOSIMETRY

Personnel dosimetry (whole body TLD badges and TLD ring badges) is issued to individuals based on the type and amount of RAM being used as indicated on the IP/TO’s application for authorization to use RAM. 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 RSO maintains a file of radiation exposure history reports in the EHS office. If you are interested in finding out the amount of exposure you have received, contact the RSO. ***It is each individual's responsibility to be aware of their received exposure.***

8.1 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/cleanroom suit 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 NY CREATES badges for Albany NanoTech Complex (ANC) related exposures. If you are required to travel to other facilities, contact the RSO for consultation and possible 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 RAM work areas and RAM storage areas. Dosimetry badges shall ***NOT*** be taken home.

7) Notify the RSO if:

   a) An individual no longer needs personal monitoring.

   b) An individual not presently monitored requires badging.

   c) An individual loses or damages their dosimetry badge.

9 RADIATION PRODUCING EQUIPMENT

All radiation producing equipment on site must be registered with the NYSDOH. The RSO must approve any radiation producing equipment entering or leaving the site via **EHS-00016-F1 –** New Equipment and Process Change Checklist. **EHS-00066-F2 –** Radiation Device Inventory shall also be submitted for all radiation producing equipment. This equipment is primarily electron microscopes and analytical X-ray equipment.

Electron microscopes produce radiation in the form of X-rays when they are in use. They result when the primary electron beam or backscattered electrons off the sample have sufficient energy to produce X-ray radiation. X-ray leakage is a concern near the junctions of the casing; however, modern electron microscopes are well shielded and generally do not produce exposure rates above background.

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 4×10^5 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 X-ray 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 are essential to detect any of the situations discussed above. Surveys shall be done with Geiger (GM) counters with thin window pancake probes. The survey is done 2'' above the surface of the area surveyed. All results are to be recorded on **EHS-00066-F3** – Radiation Survey Sheet.

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 is strongly recommended.

9.1 Additional Responsibilities (Radiation Equipment Users)

9.1.1 PI/TO 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 EHS office. The RSO is responsible for ensuring that all new PIs are informed of local procedures and policies for ordering/purchasing any type of radiation producing equipment.

PI/TO are responsible for the direct implementation of this section. Specifically, PIs, TOs, 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 and radiation producing equipment.

3) Approve all individuals who are to operate any analytical X-ray equipment and radiation producing 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 RSO) all modifications to X-ray equipment and radiation producing equipment that may significantly alter the safety status of the facility or the unit itself.

5) 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.

6) Contact the RSO to survey equipment after any changes that may affect the X-ray / radiation producing equipment or shielding.

9.1.2 Users are responsible for complying with all provisions of this section.

9.1.3 RSO is responsible for assisting in the implementation of this section. Specifically, the RSO, or designee, will:

1) Assist the PI/TO in establishing operational procedures pertaining to radiation safety.

2) Review the PI/TO'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 PI/TO in reviewing and approving modifications pertaining to the radiation safety program.

4) Perform initial and periodic radiation surveys, as needed.

5) Maintain a current inventory of all radiation producing devices on site.

9.2 Area Requirements

Radiation Area – Means any area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.05 mSv (0.005 rem) in 1 hour at 30 centimeters from the source of radiation or from any surface that the radiation penetrates. These areas shall be posted "CAUTION, RADIATION AREA."

Controlled Area or Restricted – 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 as a radiation area. Each controlled area should be identified by an appropriate and easily recognizable sign posted at each entrance.

Noncontrolled Area or Unrestricted – Any area to which access is not controlled for purposes of radiation protection.

9.3 Operational Safeguards

9.3.1 The following recommendations are applicable to all X-ray producing equipment:

1) 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.

2) 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.

3) 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. See Appendix A for examples of sufficient warning labels.

4) 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.

5) 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. See Appendix A for examples of sufficient warning labels.

6) A label bearing the conventional radiation symbol and a statement of (a) the type of RAM, 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. See Appendix A for examples of sufficient warning labels.

7) Normal operation procedures and alignment procedures shall be documented by the manufacturer of the X-ray system, or by the PI if the radiation source housing and X-ray accessory apparatus are not compatible components supplied by the same manufacturer.

8) All safety devices (shutters, warning lights, etc.) should be tested quarterly by users to ensure their proper operation.

9) Any attempt to alter safety devices either temporarily or on a permanent basis shall be approved by the PI and the RSO. A warning of the alteration shall be conspicuously posted. Radiation surveys shall be performed by the RSO after each alteration of safety devices. Records of these surveys shall be maintained.

9.3.2 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 2 inches 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 **each** port, in every source housing, associated with the system.

9.3.3 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 2 inches 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 anyone (1) hour or 100 mrem in any five (5) consecutive days.

10 RADIOACTIVE SEALED SOURCE POLICIES

A list of radioactive sources used on site, is available from the RSO. These sources must not leave their approved use and storage locations unless authorization is given by the RSO. Contact the RSO to check out/check in radioactive sources.

10.1 Site Policies:

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

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 non-controlled areas without specific approval of the RSO.

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 RSO immediately to perform a leak test.

5) Do not leave any source that produces more than 5 mrem/hr. at 12 inches unattended unless specific arrangements are made with the RSO.

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

7) Contact the RSO to have a radiation survey instrument immediately available when radiation levels in excess of 2 mrem/hr. are expected to be 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) Contact the EHS office and RSO prior to ordering a sealed source for approval and submit **EHS-00066-F6 Radiation Sealed Source Inventory**.

10) All devices/tools containing a radioactive sealed source must be labeled appropriately. See Appendix A for an example of a sufficient label.

11) The RSO or designee will maintain a current inventory of all radioactive sealed sources.

10.2 Leak Test Requirements

Each sealed source containing RAM other than H-3, with a half-life greater than 30 days, and in any form other than gas shall be tested for leakage as detailed in Sections 10.3.2-10.3.4.

10.2.1 Beta/Gamma Emitters, Ni-63 (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.

10.2.2 Alpha Emitters, Po-210 (Source must contain greater than 10 μCi):

1) Prior to initial use

2) Every three months

3) Damaged or suspected leakage

Any licensed sealed source is exempt from such leak tests when the source contains 100 microcuries or less of beta and/or gamma emitting material or 10 microcuries or less of alpha emitting material.

Sources exempt from this test shall be tested for leakage prior to any use or transfer to another person unless they have been leak tested within six months prior to the date of use or transfer.

11 STANDARDS RELATING TO LABORATORY PRACTICES

11.1 Authorization to Use RAM

The site is issued a general RAM license through the NYSDOH, Bureau of Environmental Radiation Protection, which allows the possession, use, transfer, and disposal of RAM. All PI/TOs using RAM on site must be authorized to do so by the RSO. Authorizations are granted to qualified individuals who are the PI/TOs of research projects and/or responsible for supervising RAM use by associate users or students in their area or on their tool.

All laboratory areas where RAM will be used must be approved by the RSO.

11.1.1 An individual requesting approval to use RAM must submit the following information to the RSO and EHS office:

1) The requested isotope, quantity, physical/ chemical form, and activity in mCi

2) The protocols for each intended use of RAM

3) PI's résumé with specifics on previous RAM use

All applications for the use of RAM are reviewed by the RSO for regulatory and license compliance. If the application is approved, the RSO sends a note to the PI/TO establishing what isotopes were approved and what the maximum activity limits are for each isotope. Any stipulations that the RSO has mandated will be included in this note. A Radioactive Materials License certificate is issued and must be posted in the laboratory. The RSO oversees all preliminary lab setups, postings, and initial radiation safety training for NYCREATES employees.

11.2 Ordering RAM

Prior to the purchase of any quantity of RAM, an individual must have the approval of the RSO for that specific isotope, amount of activity, and general chemical form to be ordered. **NO QUANTITY OF RAM IS EXEMPT FROM THIS PROCEDURE**.

The RSO must approve all radioisotope orders (this includes samples, regardless of whether or not there is a charge for them). Quantities ordered may not allow the area to exceed its authorized possession limits. PIs must maintain a record of all RAM in their possession.

11.2.1 To Order:

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

2) The requisition should be signed by an authorized PI/TO or an approved designee.

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

4) Email to purchasing. Purchasing must place order to the attention of the EHS department.

11.3 Receiving RAM and Sources

Radioisotopes and sources are delivered to the site via the NFN loading dock. The RSO or the RSO's designee will check in, survey, wipe test, and inspect all RAM packages prior to them being released to the laboratories or cleanroom for all quantities of RAM that exceeds the Type A_2 quantities of NYSDOH Part 16 under Appendix 16-B. The PI/TO is responsible for inspecting and surveying inside the primary packaging during initial opening. If the internal container is damaged or contamination is found, contact the RSO immediately.

As soon as your lab receives a package of RAM, the RSO or designee is to follow the SOP in Appendix B, SOP for Opening Packages of RAM.

If the RSO or designee is not available to 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 Security and the RSO immediately.

3) Measure exposure rate, using an ion chamber, at 3 feet (or 1 m) from the package surface as well as adjacent to the package surface and record the reading. If it is higher than 0.5 mR/hr., stop and notify Security and the RSO immediately.

4) Open the package while following precautionary steps:

   a) Open the outer package (following manufacturer'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 the 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 it 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.

11.4 Radiation Protection Procedures

Each user shall be aware of the methods or procedures that can be used to reduce their radiation exposure when working with radiation sources. To limit external radiation exposure, you can reduce the time spent using RAM, 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 RAM handled, and make sure the RAM are properly contained. The policies outlined below should be followed whenever you use RAM.

11.5 Policies for Safe Use of RAM

1) Prior to performing operations with quantities of RAM 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 RSO must be consulted before beginning any new use of RAM.

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

3) Smoking is prohibited in locations where unsealed sources of RAM are used or stored.

4) Do not store food, drink, or personal effects with RAM.

5) MOUTH PIPETTING IS PROHIBITED in all work areas.

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

7) Cleanroom suits/lab coats and disposable gloves shall be worn during operations involving the handling of unsealed sources of RAM. The cleanroom suit/lab coat and gloves should be removed before leaving the work area. Care must be taken such that other items (i.e., pens, pencils, notebooks, doorknobs, telephones, etc.) are NOT handled with gloves used during work with RAM.

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 RAM. Personnel should monitor themselves including hands, body, hair, shoes, and clothing. If contamination is present, decontamination shall be completed before leaving the area. Hands should be washed before leaving the laboratory.

10) Security and the RSO shall be informed immediately when there has been a spill of RAM involving personnel contamination.

11) Objects and equipment that may have been contaminated with RAM shall be surveyed by the RSO and demonstrated to be free of contamination prior to their removal from a laboratory or transfer to other laboratories, repair shops, surplus, etc.

12) RAM areas must be **locked** when unattended unless all radioactive sources are otherwise secured. When areas with RAM are unoccupied, they shall be locked.

13) RAM must always be locked when in storage either in a lockbox inside a refrigerator or in a locked refrigerator.

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

15) Issued personnel monitoring devices should be worn at all times when in areas where RAM are used or stored. These devices should be worn as prescribed by the RSO. Personnel monitoring devices should be stored in designated low background areas when they are not being worn to monitor occupational exposures. They shall not be shared with another individual.

16) Dispose of radioactive waste only in the manner designated by the RSO and maintain records as instructed.

17) Always transport RAM in shielded containers.

18) RAM lab rules shall always be posted, see Appendix C.

19) No radioactive labels or markings including the radiation symbol shall be disposed of in regular trash.

20) Areas of radioactive work shall always be kept separate from non-radioactive work.

11.6 Removable Contamination Limits

The site's policy is to keep contamination levels **as low as reasonably achievable (ALARA)**. 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 Security and the RSO 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 workday. Removable contamination levels greater than 2000 dpm/100 cm^2 must be decontaminated immediately. These area survey results should be documented 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 non-controlled 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 have radiation contamination surveys performed. These labs are subject to periodic RSO inspection.

A lab is considered “inactive” when:

- No handling of RAM 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 RSO stating such.

The PI is required to inform the RSO when working with RAM recommences. A request for an order of RAM will automatically reactivate the lab.

A full wipe test survey by the RSO or designee is completed when a lab reactivates.

All inactive labs must have the correct posting. See appendix A for an example.

The RSO may choose to review labs that remain inactive for > 6 months to verify the continued need for RAM use approval.

For a lab to go from “inactive” status to “decommissioned” status, a full survey by the RSO or designee must be performed. Once a lab is decommissioned, no RAM can be used until authorization from the RSO is given.

12 RADIOACTIVE WASTE DISPOSAL

Current instructions for the disposal of each category of radioactive waste is available through the RSO. These instructions should be carefully followed. In light of the recent problems with shallow-land burial sites, volume and waste reduction methods should be implemented in all areas. 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 RSO. 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 (e.g., 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 decayed waste, the RSO will survey the waste and approve its disposal.

4) **Sanitary Sewer System Disposal.** Only laboratories that have received specific permission from the RSO can dispose of RAM via the sanitary sewer system. RAM 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 (μCi / month)
^{3}H	3000
^{14}C	1600
^{35}S	2000
^{32}P	600
^{33}P	160
^{36}Cl	160
All others combined	160

12.1 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 transferred to the RSO for disposal. Records containing waste type, activity, and volume must be submitted upon transfer.

3) High-energy beta emitter (i.e., ^{32}P) 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 overflow. If the waste bag has a hole in it, put a second bag around it prior to placing it in storage. Use designated labels on waste bags and include the following information: type of isotope, approximate activity, date of closing bag, and date of decay.

5) Radioactive waste should not be stored under sinks.

6) Radioactive waste should not be stored with other hazardous materials.

13 BIOASSAY REQUIREMENTS

13.1 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 ^{125}I and ^{131}I). The RSO shall be notified of Radioiodine use so that arrangements for a thyroid bioassay within 48-72 hours of use can be made, if necessary.

13.2 Tritium

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

14 SPILL PROCEDURES

All spills of RAM 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 RAM. If assistance is needed, contact Security for ERT response.

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

Minor Incidents/Spills – Spills involving < 200 µCi of any beta emitting isotope in a controlled area.

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

14.1.1 Minor Incident / Spills

1) **Notify:** Notify people 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 it into a plastic bag and dispose of it 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 the incident to the RSO.

14.1.2 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 place signage on the door to prevent entry.

3) **Call for Help:** Call the emergency number (518) 437-8600 or x78600 from a campus phone.

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 and then flush contaminated skin with lukewarm 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.

14.1.3 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 it to the survey map(s) if necessary. Submit to the RSO.

3) **Corrective Action.** All individuals involved in the incident shall re-read this Radiation Safety Manual to ensure they understand the current policy, safety practices and that all activities meet these requirements. Upon review by the RSO, the individuals may require additional or re-training.

15 APPENDICES

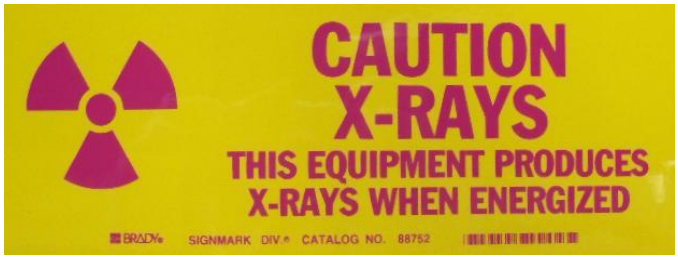
Appendix A – Common Stickers, Postings, and Warning Labels

Appendix B – Standard Operating Procedure (SOP) for Opening Packages of RAM

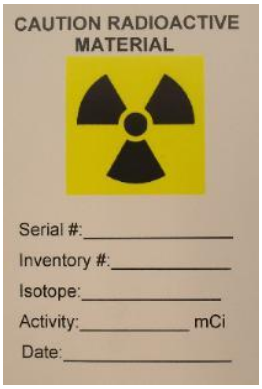
Appendix C – RAM Laboratory Safety Rules

Appendix A - Common Stickers, Postings and Warning Labels

Stickers for Radiation Producing Devices:

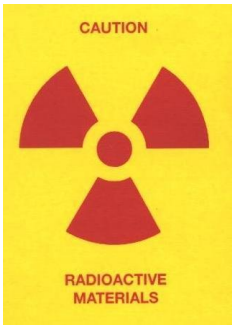


Sticker for Sealed Sources:

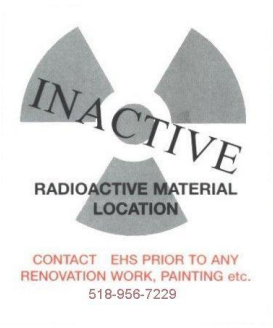


Posting for Radiation Producing Areas:

Postings for RAM Use Labs:



Posting for Inactive Labs:



Appendix B - Standard Operating Procedure (SOP) for Opening Packages of RAM

This SOP applies to all labs and individuals who receive packages of RAM after it has been initially checked in, surveyed, and delivered by the RSO or designee.

Follow these steps immediately when you first receive a package of RAM:

1) Before signing for the package, verify that the packing slip matches the isotope, material, and quantity ordered.

2) Wear gloves, a lab coat, safety glasses, and dosimeter.

3) Wipe test the outside and inside of the package.

4) For all isotopes other than ^{3}H, hold the wipe up to a survey meter (a pancake probe for ^{14}C, ^{32}P, and ^{35}S or a sodium iodide probe for ^{125}I).

5) For ^{3}H, a liquid scintillation counter must be used.

6) If the readings are consistent with background, you must deface ALL radioactive markings and symbols and dispose of the box in regular trash.

7) If the readings are above background, place in solid radioactive waste and contact EHS.

8) Retrieve correct shielding (Lucite or plexiglass shielding for high energy beta emitters such as ^{32}P and lead shielding for gamma emitters such as ^{125}I) and survey the lead or plastic pig and inner vial using the same method mentioned above for the packaging.

9) If the readings are consistent with background, place the pig and vial in a secure area such as a lockbox in a refrigerator or a locked refrigerator.

10) If the readings are above background, contact EHS immediately

11) Dispose of all dry ice (if any) correctly.

Appendix C - RAM Laboratory Safety Rules

1) This laboratory, Room _____, is only authorized for use of the following radioisotopes: _____, _____, _____, _____.
2) Work must follow the procedures adopted by the PI as submitted to the RSO.
3) Lab personnel should not work with radioisotopes unless they have attended an initial radiation safety training session and received hands-on training by the PI or designee.
4) Laboratory coats, gloves, and safety glasses must be worn when working with radioisotopes.
5) Do not eat, drink, smoke, chew gum, or apply cosmetics in the laboratory.
6) Do not store food or beverages in the laboratory.
7) Do not pipette *anything* by mouth.
8) Wash hands after handling any RAM and before doing anything else.
9) Before leaving, clean up the work area and dispose of waste into appropriately segregated waste containers.
10) Perform a post-experiment survey of yourself and your work area.
11) Provide for the security of all RAM, including stock vials and waste containers. Challenge unauthorized persons entering the laboratory.
12) Report all accidents (spills, injuries) to Security (518-437-8600).

Questions on these rules should be referred to your laboratory supervisor or to the Site EHS office.