

Cornell University

RADIATION SAFETY MANUAL

Radiation Safety Committee

Rules and Regulations Covering the Use of Ionizing Radiation

Introduction

All radioactive materials must be acquired, possessed, and used at Cornell University facilities following the procedures described in this manual. This includes exempt quantities of radioactivity. These procedures exist to protect the welfare of individuals and the environment and to comply with the stringent regulatory requirements established by the U.S. Nuclear Regulatory Commission, the New York State Department of Health, and the New York State Department of Environmental Conservation.

Cornell University is subject to periodic inspection to ensure that all regulatory requirements are met. These inspections are very thorough, including monitoring checks of laboratory areas, inspection of procurement and disposition records, records of the qualifications of individual users, and records of personnel exposure. Violations of license requirements can result in the suspension or loss of authorization to use radioactive materials.

Radiation sources other than radioactive materials, such as x-ray machines, high voltage particle accelerators, and electron microscopes are regulated by the New York State Department of Health and are also subject to the provisions of this manual.

Cornell University requires exposure to radiation is kept As Low As Reasonably Achievable (ALARA) as explained below:

Management's ALARA statement

Cornell University strongly endorses and adopts the principle of keeping exposures to ionizing radiation ALARA. ALARA means making every reasonable effort to maintain exposures to radiation as far below the dose limits set by State and Federal regulations as practical, taking into consideration technical, economic and social considerations. (NRC 10 CFR 20)

All radiation safety programs and radiation use projects are designed with ALARA as a governing principle. Procedures, equipment and facilities are designed such that exposures are minimized to the extent that the overall benefits justify the measures taken.

The University Radiation Safety Committee develops policies, approves permit holders, and reviews procedures. Technically qualified personnel provide instruction and guidance to faculty, staff and students in the implementation and responsibilities of ALARA.

Radiation safety pyramid

Many people play important roles in radiation safety. The reverse pyramid below illustrates the flow of responsibility for each of the individuals or groups at Cornell and what their major functions are. Briefly, a radioactive material (RAM) license is issued to Cornell by the New York State Department of Health (NYS DOH) which requires the management of the radiation safety program by a Radiation Safety Committee (RSC). The Radiation Safety Officer (RSO) and staff implement the safety program approved by the RSC. Permit Holders are responsible for following the radiation safety requirements and ensuring safety in labs and other spaces under

their control. Although users are at the bottom of this pyramid, they are the most important link in the chain of responsibility because they actually handle and use the RAM or radiation source. Much of the RSO and staff interactions on campus occur directly with the user.

Cornell's RAM License

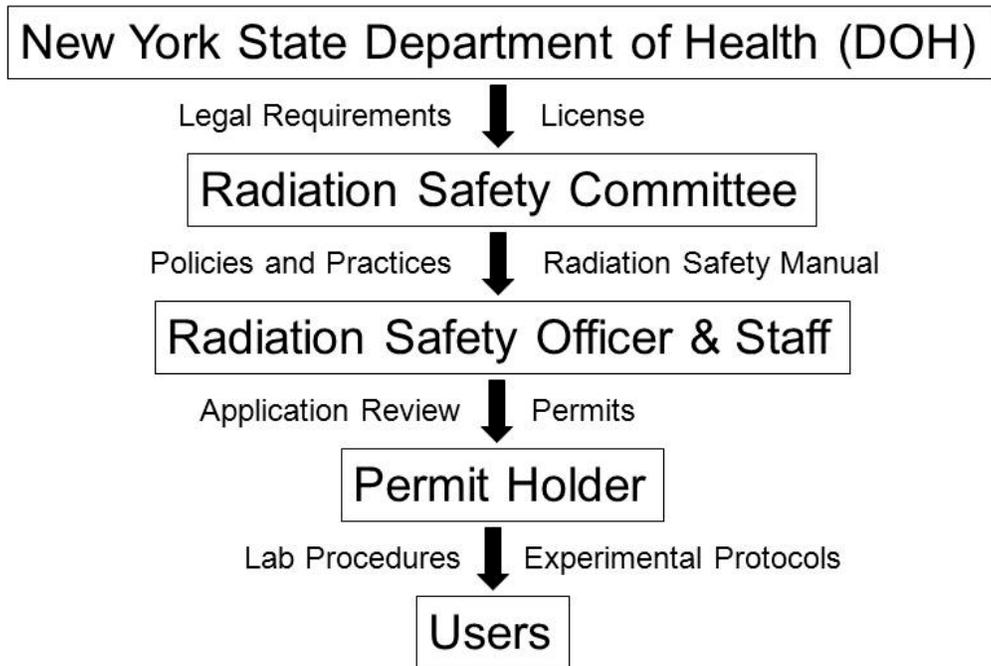


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Chapter 1: General

1.1. These Rules and Regulations do not provide complete information on radiological health protection, but are intended to outline procedures approved by the Radiation Safety Committee (RSC). Individual users should familiarize themselves with [New York State Codes, Rules, and Regulations, Title 10, Part 16: Ionizing Radiation](#).

1.2. The RSC may from time to time amend or modify these Rules and Regulations. Such amendments shall become effective when published.

1.3. The RSC may impose requirements, as it deems appropriate or necessary, to protect health or to minimize danger to property.

1.4. The RSC must approve all use of radioisotopes, sealed sources of radiation, and radiation producing equipment (RPE) through the issuance of Permits and Registrations (see Chapters 3, 4 and 7). All radioactive material shall be procured under the Radioactive Material License issued to Cornell University (CU) by the New York State Department of Health (NYSDOH). Individual permits may not be used for such procurement.

1.5. Violations of safety practices may result in the loss of RSC approval to use sources of ionizing radiation until corrective measures are taken. Such violations, which are not corrected after reasonable notice and negotiation, will be reported by the RSC to the appropriate Director, Dean or Department Head.

1.6. The RSO and/or RSC may issue Special Conditions to permits granting exemptions from the requirements of these regulations if the exemption will not result in undue hazard and is consistent with all Federal, State and local regulations.

1.7. No sealed or unsealed sources of radioactive material (RAM) or ionizing RPE shall be brought into or removed from the University except through the procedures listed or by special and written arrangements with the RSC. Transfer of these items is permissible only after approval is obtained from the RSO.

1.8. Plans and specifications for the construction of new radiation facilities, or the major modification of existing facilities, shall be approved by the RSC. The approval of such plans shall not preclude the requirement of additional modifications should a subsequent analysis of operating conditions indicate the possibility of an individual's receiving a dose in excess of the applicable standards. The responsibility of presenting the specification for approval rests with the Head of the Department concerned, or with the appropriate Deans, Directors, or the University Provost when the proposed construction involves more than one department.

Chapter 2: Radiation Safety Responsibilities

2.1. Radiation Safety Committee Responsibility: The RSC shall have overall responsibility for determining radiation safety program requirements. Additional responsibilities include, but are not limited to, the following:

2.1.1. Review applications for the use of radiation sources within the University from the standpoint of radiological health and safety. This may be accomplished by a RSC sub-committee or a member representative of the committee and approval issued.

2.1.2. Prescribe special conditions that may be necessary, such as physical examinations, additional training, designation of limited area or location of use, waste disposal methods, etc.

2.1.3. Review records and receive reports from the RSO or individuals responsible for health and safety practices.

2.1.4. Enforce remedial action when a person fails to observe safety rules and recommendations. Keep records of quarterly and emergency meetings and of actions taken.

2.2. Radiation Safety Officer Responsibility: The RSO shall have the following responsibilities:

2.2.1. Authorization of radioactive materials and RPE procurement and the receipt and distribution of all radioactive materials and RPE entering the University.

2.2.2. Enforcement of operational procedures regarding the safe handling and administration of radioactive materials and RPE.

- 2.2.3. Maintenance of an inventory record system to account for all radioactive materials and RPE entering and leaving the University.
- 2.2.4. Administration of personnel and environmental monitoring programs, including the maintenance of all necessary records.
- 2.2.5. Maintenance of a central storage facility for radioactive materials not currently in use.
- 2.2.6. Systematic inspection and survey of all radiation controlled areas within the University to determine the extent to which safety requirements are being met.
- 2.2.7. Shipment of radioactive materials, including the disposal of radioactive waste.
- 2.2.8. Submission of written reports to the RSC at such times as may be necessary on its activities and findings revealed by inspections.
- 2.2.9. Assistance to the RSC in the development of such safety programs as it may deem desirable.
- 2.2.10. Take immediate charge in the case of all accidents involving radioactive materials and RPE and take such measures as may be required to return the area to a safe operating condition.
- 2.2.11. Report for the RSC as may be required by the Federal, State, and City agencies concerned with community radiation control.

2.3. Departmental Responsibility: Responsibility for compliance with radiation safety requirements within the various University departments, or similar administrative units, lies with the heads of these units. In general, the department head shall encourage the use of proper radiation safety practices within the lab to:

- 2.3.1. Assure basic requirements are being met.
- 2.3.2. Be alert to and inform the RSO of any possible observed violations, unsafe practices or conditions, or unusual incidents or activities.
- 2.3.3. Ensure violations are corrected and action plans prevent reoccurrences. EHS can provide summary metrics when requested.

2.4. Permit Holder Responsibility: Permit Holders are responsible for an understanding of applicable parts of this manual, ensuring that individuals under their control discharge their responsibilities, and the following:

- 2.4.1. Adequate planning. Refer to procedural outlines in the permit application. Rehearse procedures before performing them with radiation to preclude unexpected circumstances. In any situation where there is appreciable radiation hazard, the RSO shall participate in the initial proceedings.
- 2.4.2. Ensuring that all individuals not authorized to work with radioactive materials are aware of the following:

- 2.4.2.1. That radioactive materials are being used and where.
- 2.4.2.2. Radioactive material storage and waste locations.
- 2.4.2.3. Precautions to take in controlled areas.
- 2.4.2.4. How to respond to emergencies.
- 2.4.2.5. What to do when radioactive material packages are delivered to the lab.
- 2.4.3. Ensuring that all individuals authorized to work with radioactive materials are instructed in the following:
 - 2.4.3.1. Procedures and precautions to minimize exposure and contamination.
 - 2.4.3.2. Purposes and functions of protective devices.
 - 2.4.3.3. Reporting requirements (see Chapter 11).
 - 2.4.3.4. Responses to emergencies or malfunctions (see Chapter 10).
 - 2.4.3.5. Health protection issues associated with radiation exposure.
- 2.4.4. Providing the RSO with written information concerning any changes in personnel, technique, facilities, etc. to effect a permit amendment.
- 2.4.5. Complying with the regulations governing the use of radioactive materials and RPE as established by the RSC for:
 - 2.4.5.1. Procuring of radioactive materials and RPE by purchase using the established procedure. Take steps to prevent the transfer of radioactive materials to unauthorized individuals.
 - 2.4.5.2. Posting areas where radioisotopes are kept and used, or where radiation fields may exist.
 - 2.4.5.3. Maintaining inventory records indicating the receipt, dispensation, disposition, transfer and disposal of radioactive materials and performing a physical inventory four times a year.
 - 2.4.5.4. Assuring that all radioactive waste is disposed of in accordance with this Manual.
 - 2.4.5.5. Securing radioactive materials and RPE against their unauthorized usage or removal from their place of storage.
 - 2.4.5.6. Performing and recording lab surveys to assure contamination and radiation levels are kept to a minimum.
 - 2.4.5.7. Making available the appropriate apparel, shielding and monitoring equipment to assure minimal exposure and contamination.

- 2.4.5.8. Allowing inspectors access to all laboratory and other spaces at all times.
- 2.4.6. Keeping stocks of stored radioactive materials to a minimum within laboratory areas.
- 2.4.7. Notifying the RSO in writing when time away from Cornell is expected to be six (6) weeks or more. A substitute permit holder shall be named and agree in writing to accept the responsibility for the permit for the duration of the leave. Approval of the arrangement will be made by the RSO. A permit amendment is issued to reflect the change. The substitute permit holder must hold a currently active permit.
- 2.4.8. Notifying the RSO 30 days in advance of termination of employment, termination of the permit, or moving out of a lab controlled for radiation hazards.
- 2.4.9. Ensure that all users know how to access and have reasonable ability, within the main lab or space where radioactive materials or radiation sources are used, to access the online Radiation Safety Manual. The online version is available at the following website: <https://sp.ehs.cornell.edu/lab-research-safety/radiation/radiation-safety-manual/Pages/default.aspx>
- The online version of the Radiation Safety Manual is the preferred method of accessing the manual in the lab.
- Alternatively, Permit Holders who choose to maintain a hard copy manual or local electronic copies will be responsible for ensuring the manual in their lab is current.
- The Permit Holder must maintain the most current printed copies of the Permit and Permit Application in the main lab for users to view.
- 2.4.10. Notifying the RSO of incidents as listed in Chapter 11.

2.5. Individual User Responsibility: Each individual who, at any time, has control over a source of ionizing radiation is responsible for obtaining an understanding of the contents of this manual, and for:

- 2.5.1. Maintaining compliance with the dose limits and CU ALARA Guidelines as described in Chapter 8 of this manual.
- 2.5.2. Wearing the prescribed monitoring equipment, such as badges and rings, as described in Chapter 8 of this manual.
- 2.5.3. Utilizing all appropriate protective measures, such as:
- 2.5.3.1. Wearing a lab coat and disposable gloves at a minimum whenever contamination is possible, and not wearing such articles outside of the laboratory area. Other personnel protective equipment, if necessary, is specified in the permit. Protective eyewear is required.
- 2.5.3.2. Using protective barriers and other shields whenever possible.
- 2.5.3.3. Using mechanical devices whenever their aid will assist in reducing exposure.

2.5.3.4. Using pipette filling devices. Never pipette radioactive solutions by mouth.

2.5.3.5. Performing radioactive work within confines of an approved hood or glove box whenever an airborne hazard exists.

2.5.4. Abstaining from eating, drinking, using tobacco products, and applying cosmetics in isotope laboratories. Refrigerators shall not be used jointly for foods and radioactive materials.

2.5.5. Maintaining good personal hygiene.

2.5.5.1. Keep fingernails short and clean.

2.5.5.2. Do not work with radioactive materials if there is a break in skin below the wrist.

2.5.5.3. Wash hands and arms thoroughly before handling any object that goes to the mouth, nose, or eyes.

2.5.6. Performing contamination and dose surveys with a portable survey meter in the immediate areas, such as hoods, benches, floor, etc., during and after each use of unsealed radioactive materials. Frequently monitor gloves for contamination during use, and monitor yourself, including lab coat and shoes, after using unsealed radioactive material. Any contamination observed shall be immediately cleaned and re-checked. See Chapter 5 for permissible contamination levels, dose rate limits and guidance in surveying of radiation areas and laboratories.

2.5.7. Keeping the laboratory neat and clean. The work area should be free from equipment and materials not required for the immediate procedure. Keep or transport materials in such a manner as to prevent breakage or spillage (secondary containment), and to ensure adequate shielding. Whenever practical, keep work surfaces covered with absorbent material with plastic backing, preferably in a stainless steel tray or pan, to limit and collect spillage in case of accident.

2.5.8. Labeling and isolating radioactive waste and equipment, such as glassware, used in laboratories for radioactive materials. Once used for radioactive substances, equipment shall not be used for other work, sent from the area to central cleaning facilities or repair shops until demonstrated to be free of contamination.

2.5.9. Requesting RSO supervision of any emergency repair of contaminated equipment in the laboratory by personnel from outside the lab or repair/service vendors. At no time shall servicing personnel be permitted to work on equipment in radiation areas without the presence of a member of the laboratory staff to provide specific information.

2.5.10. Reporting accidental skin contamination, inhalation, ingestion, or injury involving radioactive materials or radiation sources to Cornell Police at 911. Cornell Police will notify the EHS HazMat team. (See Chapter 10, section 10.2.2.7) All affected individuals shall carry out the recommendations of the emergency response personnel and/or RSO, as well as cooperate in any and all attempts to evaluate exposures.

2.5.11. Carrying out decontamination procedures when necessary and taking the necessary steps to prevent the spread of contamination to other areas.

2.5.12. Complying with requests from the RSO for internal exposure measurements and the submission of samples for radio-bioassay. Requests for these tests will be made in the case of workers using significant quantities of unsealed radioactive materials or in case of potential accidental inhalation or ingestion.

2.5.13. Promptly reporting any condition that may cause a violation of regulations or unnecessary exposure to radiation or to radioactive materials (see Chapter 11).

2.5.14. Performing only authorized protocols using the authorized isotopes and limits, authorized rooms and abiding with all conditions listed in the permit. Confer with the permit holder about an amendment to the permit if a change is necessary to accommodate needs.

Chapter 3: Unsealed Radioactive Materials

Possession and use of radioactive materials at Cornell is authorized by a radioactive materials license issued by the NYSDOH. As required by the license, the use of radioactive material is restricted to specific individuals and locations authorized by the University RSC. This requirement applies to all radioactive material, including generally licensed and exempt quantity material.

All possession and use of licensed, unsealed radioactive material at Cornell requires a formal written authorization issued by the RSC called a permit.

3.1. Permit Application: The RSC is responsible for ensuring that radioactive materials are used safely and in compliance with ALARA. This is accomplished, in part, by formal review of a written permit application for the proposed radioisotope use. The application describes the isotope(s), amount(s), facilities, experimental procedures, hazards, precautions and the qualifications of the applicant.

In order to qualify for a permit, an applicant must be a member of the Cornell faculty or qualified staff approved by the unit leader. Other individuals wishing to utilize radioisotopes must work under the supervision of a permit holder.

The training and experience required to be granted a permit depends on the type and amount of radioactive material to be used, and on the manner in which it will be used. In general, a permit applicant will be expected to demonstrate adequate knowledge of:

- 3.1.1. The principles and practices of radiation safety.
- 3.1.2. Radiation measurements, standardization, monitoring techniques, and instrumentation.
- 3.1.3. Good laboratory practices in the handling, storing, and disposal of radioactive materials.
- 3.1.4. Mathematics and calculation techniques basic to the use of radioactivity.
- 3.1.5. The biological effects of radiation.
- 3.1.6. Emergency procedures.

This knowledge is obtained through required radiation safety training provided by the RSO and from training and/or experience received prior to Cornell.

If a faculty member or senior research associate does not have adequate qualifications to be granted a permit, additional experience can be gained by working under the supervision of a more experienced colleague who is a permit holder. When the experience gained is sufficient to work independently, the application will be considered.

To become a permit holder, an individual contacts the RSO and indicates a need to use radioactive materials. The RSO meets with the individual to discuss the Cornell radiation safety

program, the duties and responsibilities of a permit holder, and the application form and process. When completed, the permit application is submitted to the RSO who reviews it for completeness and then is submitted to the RSC. A subcommittee of the RSC reviews the application and visits the laboratory or other use location to discuss the application with the applicant and to review the adequacy of the facilities. The subcommittee will either approve the application or return it to the applicant for revision.

3.2. Permit Issuance: When an application is approved, the applicant will receive a written copy of the permit. On occasion, the RSC may impose restrictions on the use of the radioactive materials, if warranted, for radiation safety and ALARA reasons. These will be stated in the permit

Permits are issued for a period of two years. Permit holders will be notified in advance of the expiration date that the permit is due for renewal. The permit holder may choose to terminate the permit or submit a request for renewal. The renewal request should specify any needed changes.

Between renewals, the permit holder may submit to the RSO written requests for amendments to the permit. The RSO will assist the permit holder as needed to provide the appropriate information. The chair of the RSC will review the request and may at his/her discretion approve it or forward it first to a subcommittee for review.

Depending on the needs of the lab, permits may be in one of the following states:

3.2.1. Active: Radioactive stocks, samples, or waste are used or stored in the facility. The facilities are subject to radiation safety requirements and oversight by EHS and the Radiation Safety Committee. Monthly surveys are required, inventory records must be kept up to date, and retraining is required annually.

3.2.2. Inactive: Labs that dispose of all radioactive stocks, samples, and waste can notify EHS that they have no inventory. EHS will inspect to confirm, and provide a memo certifying the permit status is "Inactive", at which point monthly surveys are not required. The memo is filed with monthly survey forms to explain the gap in the monthly survey records. "Inactive" permits are still inspected every six months, with emphasis on housekeeping and permitted workers staying up-to-date on refresher training.

When new inventory is received, EHS provides another memo documenting the permit status is "Active" and monthly surveys are again required.

Permits that are inactive for more than five years may be terminated.

3.2.3. Terminated: Terminated permits are not subject to Radiation Safety Committee oversight. EHS retains the application and documentation for a terminated permit. The permit may be reactivated relatively quickly if the protocols and facilities have not changed. Significant changes to protocols or facilities may require Radiation Safety Committee review similar to a new permit application. Personnel will be required to complete initial and/or refresher training to become authorized on a reactivated permit.

3.3. Permit Holder Absence: When a permit holder is expected to be away for up to six (6) weeks, the pre named Alternate Contact (AC) will be in charge of the laboratory on behalf of the permit holder. The AC will be contacted for permit related issues and will perform most of the permit holder responsibilities and functions including minor requests for permit amendments such as adding/deleting users or rooms. The permit holder will, upon return, countersign all those items which required signatures during the absence. When the permit holder and the AC are expected to be away at the same time, the permit holder must advise the RSO so that an alternate arrangement can be made.

When a permit holder is expected to be away from Cornell for six (6) weeks or more, the RSO is to be notified in writing. A substitute permit holder shall be named and agree in writing to accept the responsibility for the permit for the duration of the leave. Approval of the arrangement will be made by the RSO. A permit amendment is issued to reflect the change. The substitute permit holder must hold a currently active permit.

3.4. Permit Termination: When a permit is expected to be terminated, the permit holder must notify the RSO as far in advance as possible so EHS can help coordinate the termination process. This is particularly important when the termination is due to the permit holder's leaving the University.

Chapter 4: Radiation-Producing Equipment

A Certificate of Registration issued to Cornell University by the NYSDOH authorizes the possession and use of ionizing radiation producing equipment (RPE). New York State Sanitary Code (10 NYCRR 16) and standards issued by the American National Standards Institute specify the requirements for the safe use of this equipment. This chapter describes the policies developed by the Cornell University RSC to meet these requirements and to ensure that personnel doses from the ionizing radiation are kept ALARA.

4.1. General Requirements: The requirements of section 4.1 apply in common to the use of all ionizing RPE except for equipment operating at 10 kV or less. The sections following this section apply to the type of equipment indicated by the section heading, 4.2 Electron Microscopes, 4.3 X-ray Diffraction, 4.4 Particle Accelerators, 4.5 Radiographic.

4.1.1. Operating Permits: The RSC is responsible for ensuring that RPE is operated safely and that personnel dose from ionizing radiation produced by this equipment is kept ALARA. A permit must be obtained from the RSO in advance of any use or acquisition (by purchase, transfer, loan, donation or otherwise) of ionizing RPE at Cornell.

The permit application includes a description of the facility, equipment, operating procedures, hazard evaluation, the qualifications of the applicant and a list of operators and users. The level of detail in the permit application reflects the degree of risk posed by the proposed equipment.

Operators are defined as personnel with the training and expertise to use, repair, maintain, calibrate, dismantle and/or rebuild, modify (including beam paths, beam tubes, beam stops, shielding, safety interlocks and other safety systems) or some combination of the above. Operators also establish operating parameters for users and can provide safety training to users.

Users are trained in operating RPE to obtain data, measurements, samples, etc. within the parameters approved by the permit holder and/or operator. Users may adjust the settings of the RPE, within the boundaries provided by the permit holder or operator (e.g. the high voltage and current setting on an x-ray diffraction unit), change samples, and perform other adjustments required for the proper use of the RPE. Users also receive safety training appropriate for the work to be performed.

4.1.1.1. Qualifications: To qualify for a permit, an applicant must be a member of the Cornell faculty, qualified staff approved by the unit leader, or a licensed physician on staff at Cornell Health Services (for clinical, laboratory, or research use on humans).

The training and experience required to qualify for a permit depends upon the type and relative hazards associated with the equipment to be used. In general, a permit applicant will be expected to have previous training and experience with RPE and be able to demonstrate adequate knowledge of radiation measurements, monitoring

techniques and instrumentation, the biological effects of radiation, and emergency procedures.

4.1.1.2. **Process:** To become a permit holder, an individual contacts the RSO indicating a need to use RPE. The RSO meets with the individual to discuss the Cornell radiation safety program, explain the duties and responsibilities of a permit holder, and reviews the application form. When completed, the permit application is submitted to the RSO who reviews it for completeness and performs a site visit. At the discretion of the RSO, the application may be submitted to the RSC. The RSC will either approve the application or return it to the applicant for revision. See also 4.1.1.5, Registrations.

4.1.1.3. **Permit Approvals:** Permits are granted by the RSO with recommendations of the RSC, when provided. The RSO (or RSC) may opt not to perform a site visit in circumstances such as:

4.1.1.3.1. Electron microscopes that operate at 20 kV or less.

4.1.1.3.2. Diffraction units that operate at 30 kV or less and are small-contained units, dually interlocked, with no interlock by-pass available.

4.1.1.3.3. Radiographic units that operate at a maximum of about 70 kV and are self-contained small cabinet units, well interlocked, and can be operated without concern for dose to personnel.

After a review of the application and equipment specifications, the RSO will require a pre-operational radiation survey be conducted prior to approving the permit and equipment for use.

All equipment will be reviewed by the RSO and assigned a “hazard class” that is based on factors affecting radiation safety. Such factors include, but not limited to: equipment age; open/enclosed beams; operating voltage; inherent shielding; condition of enclosures, interlocks, and other safety equipment; etc.

4.1.1.4. **Permit Issuance:** When an application is approved, the applicant will receive a written copy of the permit. The RSO and/or RSC may impose restrictions on the use of the equipment if warranted for radiation safety and ALARA reasons. These will be stated in the permit. Permit renewals and inspection frequencies will be based on an assessment of the instrument’s hazard class.

Table 4.1: RPE Hazard Classes

Hazard Class	Description	Permit Renewal	RSC Site Visit	Inspection Frequency
1	Low	10 years	None	4 years
2	Medium	5 years	10 years	1 year
3	High	2 years	8 years	6 months

Changes or modifications to RPE should be reviewed with the RSO to ensure that radiation safety is properly addressed. In addition, some changes/modifications may require RSC review and/or approval. The RSO will provide guidance in these situations.

Between renewals, the permit holder may submit written requests to the RSO for proposed changes to conditions specified in the permit. The RSO will assist the permit holder as needed to provide the appropriate information. The RSO will review the request and may, at his/her discretion, approve it or refer it to the RSC for review and recommendations. Changes may not be implemented until written authorization is received.

For cases where human exposure is allowed by the permit, the alternate contact and/or substitute permit holder must be a University physician.

When a permit holder is expected to be away for up to six weeks, the alternate contact will be in charge of the laboratory on behalf of the permit holder. The alternate contact will be contacted for permit related issues and will perform most of the permit holder responsibilities and functions including minor requests for permit amendments such as adding/deleting users or rooms. The permit holder will, upon return, countersign all those items which required signatures during the absence. When the permit holder and the alternate contact are expected to be away at the same time, the permit holder must advise the RSO so that an alternate arrangement can be made.

When a permit holder is expected to be away from Cornell for six weeks or more, the permit holder and RSO will select a substitute permit holder who has the knowledge and expertise to be responsible for the laboratory. The substitute permit holder must agree in writing to accept the responsibility for the permit during the leave. A permit amendment will be issued to reflect the change.

4.1.1.5. Registrations: Individuals with RPE in storage, dismantled, on loan or otherwise inoperable will be issued a registration. The RSO is required to be notified before returning equipment in this category to operability and will assess if safety measures and features are appropriate. Since a permit is required for operational RPE, a permit application will be required from new owners without a current permit, or an amendment from owners with a current permit.

4.1.1.6. Permit Termination: When termination of a permit is desired, the permit holder must notify the RSO as far in advance as possible. This is particularly important when the termination is due to the permit holder's leaving the University. The permit holder will assist the RSO to ensure that:

4.1.1.6.1. All RPE still in the possession of the permit holder is properly transferred or disposed of.

4.1.1.6.2. Area/personnel monitoring is discontinued, where applicable.

4.1.1.6.3. Postings and labels are removed from the authorized area if equipment is removed from the premise.

4.1.1.6.4. Documentation of the transfer or disposal of any RPE.

4.1.2. New Facilities and Major Renovations: Plans and specifications for the construction of new radiation facilities, or the major modification of existing facilities, must be approved by the RSO. The information provided to the RSO must include, at a minimum, the technical specifications of the equipment, the facility layout, beam orientation, shielding (location and construction), occupancy of adjacent areas, and a summary of proposed operations including operating voltages, beam on times, and expected radiation levels within and immediately outside controlled areas.

If deemed necessary, the RSO may also request RSC review, approval and/or a use location visit based on the level of hazard presented by the RPE.

4.1.3. Purchases/Transfers/Dispositions: All acquisitions or disposition of RPE must be reviewed and approved in advance by the RSO. All purchase requisitions must be reviewed and approved by the RSO before the purchase may be processed.

4.1.3.1. Transfers within Cornell: Transfer of RPE between permit holders is sometimes permissible, but only with approval by the RSO before the equipment is moved. The RSO must have the opportunity, in advance, to review the new location, qualifications of the receiving permit holder, and the expected operating parameters in the new location. If the new owner is not a permit holder, a permit must be obtained before the transfer can occur.

4.1.3.2. Procurement and Transfers to or from Cornell: State and Federal regulation requires Cornell to track the possession, use and transfers of RPE.

When a transfer or purchase of RPE to Cornell is in the planning process, the owner must notify the RSO in writing and must receive written permission. The individual who plans to receive said equipment is responsible for making this requirement known to the owner.

When a transfer of RPE from Cornell is in the planning process, the sender must notify the RSO. The RSO will determine whether or not Cornell has permission to allow the transfer and will notify all the appropriate agencies.

4.1.3.3. Disposal: When the disposal or scrapping of a piece of RPE is under consideration, notify the RSO during the planning process. The device must be rendered inoperable by removal of the tube or filament. All labels, signs and notices will be removed by the RSO.

4.1.4. Instruction For Operators and Users

For Operators:

4.1.4.1. All individuals operating equipment capable of emitting a level of radiation greater than 0.5 mrem/hr at 5 cm from the surface must be instructed in the health risks associated with ionizing radiation exposure. This must include: the biological effects of ionizing radiation, procedures to minimize dose, the function and implementation of warning lights, status indicators, protective devices and shielding, operation of radiation monitoring equipment, how radiation is produced within the equipment and a summary of relevant regulations.

4.1.4.2. Safe operating procedures and radiation safety precautions must be clearly documented in a manual which must be available to the operator at all times. (See 4.1.7.2.3)

4.1.4.3. The permit holder must develop an equipment specific training program, train new operators / users and evaluate the competency of existing and new operators / users in the safe use of the equipment. The RSO or designee will approve the contents of the training program.

4.1.4.4. All training must be documented. The date(s), topics covered, and signatures of the permit holder and the trainee must be included.

4.1.4.5. Access to areas containing the operating controls for RPE must be restricted to authorized personnel only regardless of the dose rates in the area.

For Users:

4.1.4.6. All individuals using equipment capable of emitting a level of radiation greater than 0.5 mrem/hr at 5 cm from the surface must be instructed in the health risks associated with ionizing radiation exposure. This must include: the biological effects of ionizing radiation, procedures to minimize dose, the function and implementation of warning lights, status indicators, protective devices and shielding, operation of radiation monitoring equipment, how radiation is produced within the equipment and a summary of relevant regulations.

4.1.4.7. Safe operating procedures and radiation safety precautions must be read, understood and followed by all users.

4.1.4.8. All users must receive equipment specific training in the safe use of the equipment from the permit holder or an operator.

4.1.4.9. The permit holder or operator must record the training dates and signatures of all users.

4.1.4.10. Access to areas containing the operating controls for RPE must be restricted to authorized personnel only regardless of the dose rates in the area.

4.1.5. Radiation Monitoring

4.1.5.1. Personnel dosimetry (i.e. body badge and/or extremity badge) may be required if a potential for exposure exists and for certain types of equipment. Consult the appropriate section (4.3.2.5 Diffraction, 4.4.5.1 Accelerator, 4.5.8 Radiographic) of this chapter for additional details. When not required (e.g. electron microscopes), the decision to use personnel monitoring is left to the discretion of the permit holder in consultation with the RSO.

4.1.5.2. Area dosimetry badges or monitoring equipment are required for all equipment capable of emitting a level of radiation greater than 0.5 mrem/hr at 5 cm from the surface. Dosimeters are available through the RSO.

4.1.5.3. After installation and after each structural or operational modification of the equipment, the permit holder, operator, or the RSO or designee must perform and record an instrument survey to determine any change in the radiation field. This survey must be documented and precede the return of the equipment to service.

4.1.5.4. Other surveys shall be performed in accordance with procedures appropriate to the equipment. Consult the section of this chapter applicable to the specific type of equipment for details.

4.1.6. Personnel Dose Limits: The University requires that radiation doses be maintained ALARA. Chapter 8 of this manual specifies the limits and guidelines for radiation workers, pregnant radiation workers, non-radiation workers and members of the public. Section 4.3.4.4 of this chapter specifies additional limits for diffraction equipment users.

4.1.7. Area Classification, Dose Limits & Identification: Areas where personnel may be exposed to radiation are classified according to the dose rates listed in Table 4.2. The RSO, or designee, will make designation of controlled areas, during a pre-operation equipment survey. Only the RSO, or designee, may make changes in designations.

4.1.7.1. Noncontrolled Area: An area to which access is neither controlled nor restricted.

4.1.7.2. Controlled Area: An area authorized for the use and/or possession of RPE where access is restricted to authorized radiation users and accompanied visitors.

4.1.7.2.1. Temporary access to radiation and high radiation areas is allowed only to qualified personnel with permission of the RSO. Personnel monitoring devices are required and portable survey instruments must be used during access to all such areas.

4.1.7.2.2. Portable radiation survey instruments must be available to personnel who work in a controlled area or above, or adjacent to radiation area or above.

4.1.7.2.3. Written safety operating procedures must be prepared by the permit holder and approved by the RSO, in which all area designations, safety procedures and precautions shall be clearly spelled out. All qualified workers must be required to be familiar with the provisions of this manual before starting work.

4.1.7.3. Radiation Area: An access-controlled area that requires posting of *Radiation Area* signs.

4.1.7.4. High Radiation Area: An access-controlled area that now requires the posting of *High Radiation Area* signs. High radiation areas require the review and approval of the NYSDOH.

4.1.7.5. Exclusion Area: An area authorized for RPE use where access is prohibited while equipment is in operation.

4.1.7.5.1. Provisions of Sec. 4.4.3.2 must apply where applicable.

4.1.7.5.2. Continuously operating radiation monitoring devices must be installed in **and** adjacent to these areas. Such devices must provide an audible and visual warning to personnel in the vicinity when preset maximum rate is exceeded.

Table 4.2: Classification of areas and dose limits

Area	Dose Limits
Noncontrolled	Less than 2.0 mrem in 1 hour and less than 100 mrem in a year
Controlled	More than 2.0 mrem in 1 hour or more than 100 mrem in a year
Radiation area	More than 5.0 mrem in 1 hour @ 30 cm
High Radiation Area	More than 100 mrem in 1 hour @ 30 cm
Exclusion	Potential dose exceeds a high radiation area

4.1.8. Security/Access To Areas

4.1.8.1. All RPE must be secured against unauthorized operation when left unattended by the permit holder or a trained operator. When the unit is not in use, security may be accomplished by locking the power switch, the high voltage supply, or the door to the facility. When a unit is operating and unattended security may be accomplished by preventing access to the controls and controlled areas.

4.1.8.2. The access to controlled areas and above must be limited by means of barriers, and interlocks as appropriate, and indicated by the posting of the appropriate signs.

4.1.9. **Posting of Notices:** These documents must be posted in control rooms:

4.1.9.1. A current copy of the NY State required "Notice to Employees"

4.1.9.2. A copy of the New York State Certificate of Registration

4.1.9.3. Radiation Safety Manual, Chapter 4, which includes operating procedures, and operating permit.

4.1.10. **Inspections:** See Section 4.1.1.4, Permit Issuance for a discussion of RPE inspections. The permit holder must take steps to correct any violations upon receipt of such notice.

4.1.11. Violations

4.1.11.1. **Major:** Deviations from approved procedures which pose a potential for dose in excess of legal dose limits (see Chapter 8) must be considered a major violation. Such deviations must cease immediately and the RSO must be advised.

4.1.11.2. **Minor:** Situations not posing a potential for excessive radiation dose to personnel, but violating any item of this chapter, must be designated minor violations. The RSO must be advised promptly and steps to correct this type of violation must be taken within a period of time specified by the RSO.

4.1.12. **Exceptions:** Any exception to the requirements of this chapter must be applied for in writing and granted by the RSC upon demonstration by a permit holder that the requirement is unreasonable and that radiation safety can be maintained.

4.2. **Electron Microscopes (other than SEMs) and other electron-beam equipment**

4.2.1. **Labels:** A label bearing the radiation symbol and words indicating that the equipment produces X-rays must be posted near any switch which energizes the equipment.

4.2.2. **Shields:** Inherent shields must be such that when the equipment is operating at maximum potential, the radiation levels from the surface must not exceed 2 mrem/hr at 5 cm at any area of the column. Exceeding this limit may require additional shielding. Dose due to unwanted radiation such as from high voltage rectifiers, must not exceed 0.25 mrem/hr at 5 cm from the external surface. Note that area monitors are required at 0.5 mrem/hr at 5 cm per section 4.1.5.

4.2.3. **Repair**

4.2.3.1. No individual must bypass a safety device or remove shielding without approval of the permit holder. If a safety device is bypassed or shielding removed for a period of time, the permit holder or a designated person must maintain visual contact with the affected area while the unit is operational.

4.2.3.2. The electron gun must be made inoperable when repairs or modifications necessitate the disassembly of the column.

4.2.3.3. After each repair which involves the removal and replacement of shielding or which could affect X-ray production, a survey must be performed and recorded by the RSO to ensure continued safe conditions.

4.2.4. **Surveys**

4.2.4.1. Surveys will be performed annually as part of the inspection program provided by RSO.

4.2.4.2. Surveys shall be performed following repairs referenced in 4.2.3.3.

4.3. **X-ray Diffraction and Fluorescence Equipment**

4.3.1. **General Requirements:** Analytical X-ray equipment (diffraction and fluorescence) must comply with the ANSI/HPS N43.2-2001 standard *Radiation Safety for X-ray Diffraction & Fluorescence Analysis Equipment*. Copies are available from EHS.

4.3.1.1. Labels and Signs

4.3.1.1.1. Each entrance or access point to a controlled area must be conspicuously posted with a sign bearing the radiation symbol and wording appropriate for the level of radiation that might be encountered. (Refer to Table 4.2).

4.3.1.1.2. A label bearing the radiation symbol and words indicating that the equipment produces X-rays must be posted near any switch which energizes an X-ray tube and another near the port.

4.3.1.2. Tube Housings.

4.3.1.2.1. X-ray tube must not be operated without a suitable housing which restricts the radiation to a well-defined beam.

4.3.1.2.2. The inherent shielding of the housing must be such that when the tube is operating at maximum potential and all shutters are closed, the radiation levels at 5 cm must not exceed 2.0 mrem/hr.

4.3.1.2.3. Tube housings must be equipped with an interlock which disables the tube if the housing is removed or dismantled.

4.3.1.3. All ports and shutters should be of the type described in 4.3.2.

4.3.1.4. A beam trap or similar barrier with sufficient shielding so that the dose rate due to the primary beam does not exceed 0.25 mrem/hr at 5 cm from the posterior surface must be used.

4.3.1.5. A warning light or other device of **fail-safe design** bearing the words, "X-RAY ON" must be conspicuously located near any switch which energizes the X-ray tube. A similar light or device must also be mounted near the radiation tube housing.

4.3.1.6. Interlocks must be of such design that after an interruption, high voltage may be restored or shutter may be reopened only by manually resetting the controls.

4.3.1.7. No individual must bypass a safety device or interlock without the approval of the permit holder. The permit holder or designated person must be in visual contact with the affected area while the unit is operated with a safety device or interlock bypassed.

4.3.1.8. The dose due to unwanted radiation such as that from high voltage rectifiers must not exceed 0.25 mrem/hr at a 5 cm distance from the outside surface of the equipment.

4.3.1.9. A survey instrument calibrated in mrem/hr must be readily available. All authorized operators must know its location.

4.3.2. Open Beam Configurations: An open beam system is one in which enclosure is not provided in all possible X-ray paths.

4.3.2.1. Each port of the tube housing must be provided with a beam shutter interlock which interlocks the collimator or X-ray accessory apparatus coupling, in such a way that the unit will operate with the port open only when the collimator or coupling is in place.

4.3.2.2. A shutter at an unused port must be secured to prevent its casual opening.

4.3.2.3. All operative shutters must be provided with a "shutter open" indication of fail-safe design, whether the high voltage and beam are on or off, and be operated remotely.

4.3.2.4. A guard should be provided which prevents casual entry of any part of the body into the primary beam.

4.3.2.5. Operators shall wear body and extremity badges.

4.3.3. Closed Beam Configurations: A closed beam system is one in which all possible X-ray paths are fully enclosed.

4.3.3.1. The inherent shielding of the enclosure walls must be sufficient to limit the dose to 0.25 mrem/hr at 5 cm.

4.3.3.2. The enclosure shall be interlocked with the X-ray source high voltage supply or a shutter, preventing the beam from entering the sample chamber while it is open.

4.3.4. Alignment & Repair

4.3.4.1. After each change in configuration or repair of a device which could affect X-ray production, a survey must be performed and recorded by the permit holder, a designated operator, or the RSO or designee, to ensure compliance with this section. For new configurations, refer to section 4.1.5.3.

4.3.4.2. No operation involving the removal of shielding materials or tube housings or modifications to shutters, collimators or beam stops must be performed without ascertaining that the tube is turned off and that it will remain off until safe conditions have been restored.

4.3.4.3. If an alignment procedure may result in raising the dose rates above the limits of the area designation, the person shall erect temporary barriers and signs as required and maintain surveillance until normal operating conditions are resumed.

4.3.4.4. Alignment procedures should be such that a dose to the skin and extremities would not exceed 25 mrem/hr, or to the whole body, total organ, or lens of the eye would not exceed 2.5 mrem/hr. In keeping with ALARA, dose per alignment procedure

should not exceed 50 mrem total dose to extremities or 10 mrem total dose to whole body, organs, or eyes.

4.4. Particle Accelerators and Implanters: All accelerators including those operated steady state and those pulsed intermittently are covered by this section.

4.4.1. Shields & Barriers

4.4.1.1. The shields around a particle accelerator must reduce radiation hazard in the surrounding area to levels which will not exceed the allowable dose rates described in section 4.1.7

4.4.1.2. Radiation attenuation can be accomplished by a reasonable combination of barriers at a distance from radiation sources and physical shielding.

4.4.2. Control of Access & Operation

4.4.2.1. The primary controls influencing the production of radiation must be attended by the designated operator(s) during the time that the accelerator is operational. The controls must be secured when unattended in order to prevent unauthorized use.

4.4.2.2. Access to radiation areas should be limited to individuals directly concerned with the operation and maintenance of the facility, experimental or production work, radiation safety or approved visitors accompanied by facility personnel.

4.4.3. Interlocks & Warning Devices

4.4.3.1. Where visual contact with the entire exclusion area can be maintained by the operator, a visual check and audible warning will be required before commencing operation.

4.4.3.2. In larger facilities where the entire exclusion area(s) is not readily visible to the operator:

4.4.3.2.1. All entrances to exclusion areas must be provided with interlock systems, which if tripped, must render operation of the equipment impossible.

4.4.3.2.2. All exclusion areas must be provided with scram switches or other emergency power cutoff switches within easy reach and easily identifiable as to their purpose.

4.4.3.2.3. When an interlock system has been tripped, it must only be possible to resume operation by manually resetting controls at the location where the interlock had been tripped.

4.4.3.2.4. When necessity dictates that a safety interlock be temporarily bypassed, such action must be [1] authorized by the permit holder, [2] recorded in a log or other record and a notice posted at the control console, and [3] terminated as soon as possible.

4.4.3.2.5. No interlocks must be permanently bypassed without the written authorization of the RSO.

4.4.3.2.6. Exclusion areas and their entrances, must be equipped with easily observable flashing or rotating red lights which must operate during any radiation production.

4.4.4. **Safety Checks:** All safety and warning devices, including interlocks, must be serviced and checked for proper operation at six-month intervals and after any modification to the system. Documentation of the date, results and changes shall be maintained.

4.4.5. Radiation Monitoring

4.4.5.1. Personnel monitoring is required for individuals who could be exposed to a dose rate in excess of 2.0 mrem/hr.

4.4.5.2. Area monitoring is required in controlled and adjacent uncontrolled areas.

4.4.5.3. A survey instrument calibrated in mrem/hr must be available and its location must be made known to all authorized operators. Survey instruments are not required for pulsed intermittent equipment installations.

4.5. **Radiographic Installations (Human & Animal):** Procedures and auxiliary equipment designed to minimize patient and personnel dose commensurate with the needed diagnostic information must be utilized.

4.5.1. Equipment

4.5.1.1. The protective tube housing must be of diagnostic type (<100 mrem/hr @ 1 meter when operated at maximum continuous current).

4.5.1.2. Collimating devices capable of restricting the useful beam to the area of clinical interest must be used and shall provide the same degree of protection as is required of the tube housing.

4.5.1.3. The aluminum equivalent of the total filtration in the useful beam must not be less than that shown in table 4.3.

Table 4.3: Minimum total filtration

Peak Operating Voltage	Total Aluminum Equivalent Thickness
< 50 kVp	0.5 mm
50 - 70 kVp	1.5 mm
> 70 kVp	2.5 mm

4.5.1.4. The exposure switch must be of the dead-man type.

4.5.1.5. A timing device must be employed which terminates the exposure automatically after a preset time or interval.

4.5.2. Structural Shielding For Fixed Equipment

4.5.2.1. Control apparatus for the radiographic equipment must be located in an adjacent room or in a fixed booth within the same room provided such booth is composed of radiation shielding to a minimum height of seven (7) feet. The control booth either must be so arranged that the radiation has to be scattered at least twice before entering the booth or must be provided with a protective door that is interlocked in such a way that the X-ray tube(s) cannot be energized unless the door is in the closed position.

4.5.2.2. The operator must be able to see the patient by means of a mirror or through a window of lead equivalent material sufficient for the required protection, and so placed that the operator is always in a shielded position.

4.5.2.3. The exposure switch must be arranged so that an individual outside the shielded control area cannot operate it.

4.5.2.4. Interlocks installed on all doors leading to the procedures room must be checked semiannually for operability.

4.5.3. Holding of Subjects & Films

4.5.3.1. Holding of human patients or subjects is not allowed under any circumstances. When a subject must be secured in position during exposures, mechanical restraining or supporting devices must be used. Occupationally exposed individuals may only hold animal subjects when clinically necessary under extreme conditions. Such individuals must wear protective gloves having at least 0.5 mm lead equivalent, a protective apron of at least 0.25 mm lead equivalent, and must keep all body parts out of the useful beam. Declared pregnant women and individuals under age 18 must not hold patients or films under any conditions.

4.5.3.2. No person may be regularly employed to hold animals or films during exposures.

4.5.3.3. Any procedure, which requires the holding of an animal or film must be approved by the permit holder and documented.

4.5.3.4. Lead aprons and gloves must be inspected semiannually via radiograph for cracks or tears.

4.5.4. Portable/Mobile Unit Considerations

4.5.4.1. All portable/mobile equipment must be provided with a device which creates a minimum source-to-skin distance of at least 12 inches.

4.5.4.2. The exposure switch must be provided with a cord sufficiently long so that the operator can stand at least six feet from the patient, X-ray tube and the useful beam.

4.5.4.3. Protective aprons of at least 0.25 mm lead equivalent must be worn by all operators of portable/mobile equipment when taking images.

4.5.5. Fluoroscopic Considerations

4.5.5.1. Equipment must be so constructed that the entire cross section of the useful beam is always intercepted by a primary protective barrier (usually an image intensifier assembly). The exposure must automatically terminate when the barrier is removed from the useful beam.

4.5.5.2. Protective aprons of at least 0.25 mm lead equivalent must be provided and must be worn by all persons in the room.

4.5.5.3. Only persons needed in the fluoroscopic room must be present during the exposure.

4.5.5.4. For Mobile Fluoroscopic Equipment:

4.5.5.4.1. In the absence of a tabletop, a cone or spacer frame must ensure a source-to-skin distance of greater than 12 inches.

4.5.5.4.2. Image intensification must always be provided and the equipment rendered inoperable unless the useful beam is intercepted by the image intensifier.

4.5.5.5. A survey for radiation scatter at the operator position must be conducted semiannually.

4.5.6. **Patient Shielding:** For protection to the human patient during radiographic procedures in which the gonads are in the useful beam, gonadal shielding of not less than 0.5 mm lead equivalent must be used for patients who have not passed the reproductive age, except for cases in which this would interfere with the diagnostic procedure. This shielding must be inspected semiannually for cracks or tears.

4.5.7. **Quality Assurance (For Human Subjects):** A program of Quality Assurance (QA) must be established for the Gannett Clinic radiographic installation. This program for minimizing human patient dose must be developed based upon the NYSDOH requirements and the recommendations and requirements of the RSO, or designee, and shall become part of the Operating Permit.

A QA Committee must be established. The membership must include the Clinic Director or designee, the RSO, the Chief Radiological Technologist, and a Radiologist (usually from an external facility). The QA Committee must meet at least annually to review the QA program.

The program must include the following reviews:

- a) kV consistency
- b) Timer consistency
- c) mA stability
- d) Focal spot size

- e) Collimator accuracy
- f) Beam alignment
- g) Half value layer
- h) Photo timer consistency (if applicable)
- i) Darkroom environment
- j) Film storage
- k) Chemical storage
- l) Screen integrity
- m) Cassettes
- n) Retake analysis
- o) Apron, glove and patient shields integrity test
- p) Interlock operability

4.5.8. Personnel Monitoring

4.5.8.1. All operators, attendants, technicians and physicians involved with the use of radiographic equipment must wear personal monitors. A worker who declares a pregnancy (see Chapter 8.3) must wear two personal monitoring devices; one at the collar and one at the waist.

4.5.8.2. When involved in portable or fluoroscopic radiography, personal monitoring devices must be worn outside any protective apparel.

4.5.9. **Qualifications:** Only physicians, veterinarians and those technologists licensed by the NYS DOH and/or the NYS DOE must operate radiographic equipment.

4.5.10. **Pregnant Patient Medical Doses:** A sign must be conspicuously posted in the radiology waiting area which instructs all females who may be pregnant to inform the technician of that possibility. In addition, the attending physician and the technician must ask each female patient of child bearing age if there is any chance of their being pregnant. Radiography of the lower back, abdomen or pelvis must be confined to the 10 days after the onset of menses in women of child bearing age and avoided completely in pregnant patients. The decision to proceed with a radiograph in those cases where the radiograph is deemed essential is left to the discretion of the attending physician and/or consulting radiologist.

When the presence of a pregnancy is unsure, a positive or negative indication must be determined before proceeding with the examination. Radiography of other body parts may be done at any time provided the dose is limited to the particular area of interest by collimation and shielding.

Chapter 5: Policies and Procedures for Controlled and Restricted Areas

5.1. Area Definitions and Limits

5.1.1. Areas shall be defined with regard to radioactive material and radiation fields under the following classifications.

Table 5.1: Area Access Restrictions. These terms are used in this manual, permits, and operating procedures for the purpose of regulating which personnel may enter an area

Area	Definition
Uncontrolled Area	An area not subject to radiation restrictions or Radiation Safety Committee oversight
Controlled Area	An area outside a restricted area but within the site boundary, to which the licensee can limit access for any reason. Rooms subject to Radiation Safety Committee oversight are controlled areas.
Restricted Area	Any area to which access is controlled for the protection of individuals from exposure to radiation and radioactive materials. Restricted Areas will be established for the purpose of radiation protection within Controlled Area boundaries.
Exclusion Area	An area where access is prohibited while ionizing radiation is present.

Table 5.2: Radiation Field Warning Classifications. These terms are used in this manual, permits and operating procedures for the purpose of warning individuals as to the intensity of radiation fields in the area.

Area	Definition
Radiation Area	An area where an individual located 30 centimeters from any source of radiation could receive greater than 5 mrem in one hour
High Radiation Area	An area where an individual located 30 centimeters from any source of radiation could receive greater than 100 mrem in one hour
Very High Radiation Area	An area where an individual located 100 centimeters from any source of radiation could receive greater than 500,000 mrem in one hour

5.1.2. The dose in any unrestricted area shall be kept **as low as reasonably achievable** below New York State regulatory limits:

5.1.2.1. The dose in any unrestricted area from external sources does not exceed 2 mrem in any one hour; and

5.1.2.2. The total effective dose equivalent to individual members of the public does not exceed 100 mrem in a year.

5.1.3. Contamination shall be kept as low **as reasonably achievable below** New York State regulatory limits.

Table 5.3: New York State regulatory limits for surface contamination

	Fixed β/γ (mR/h)	Removable β/γ (dpm/100 cm ²)	Fixed α (dpm/100 cm ²)	Removable α (dpm/100 cm ²)
<i>Restricted Areas</i>	1	5000	5000	500
<i>Unrestricted Areas</i>	0.2	1000	100	100
<i>Skin or Personal Clothing</i>	0.1	Not Detectable	500	Not Detectable

5.1.3.1. It is the discretion of the Radiation Safety Officer and the Radiation Safety Committee to determine what level of surface contamination is reasonably achievable below the NYS limit. In most cases, keeping contamination below detectable levels is reasonably achievable.

5.1.3.2. If any individual's skin, hair or personal clothing is found to be contaminated above background readings, **immediately** contact Cornell Police by calling 255-1111. (See Chapter 10, section 10.2.2.7)

5.1.3.3. The permissible levels on glassware, tongs, lead bricks, and other laboratory equipment will be the same as those for working surfaces.

5.1.3.4. To ensure that these levels are maintained, the permit holder will perform and record routine surveys of all areas under his control.

5.2. Proper Posting of Laboratories, Areas, and Equipment

5.2.1. A "RADIOACTIVE MATERIALS USED IN THIS FACILITY" sign shall be conspicuously posted at each entrance to laboratories where radioactive materials are stored and/or are used.

5.2.2. Radioactive use and storage areas and equipment shall be conspicuously marked with a "CAUTION, RADIOACTIVE MATERIALS" sign. The perimeters of areas labeled for radiation use shall be conspicuously marked. In addition, containers in which materials are transported or stored shall bear a durable, clearly visible label bearing the radiation caution symbol and the words "CAUTION, RADIOACTIVE MATERIALS". This label shall also state the quantities and kinds of radioactive materials in the containers and the date of measurement of the quantity.

5.2.3. Radiation areas, high radiation areas and very high radiation areas, as defined in Table 5.2, shall be posted with the sign "CAUTION, RADIATION AREA", "CAUTION, HIGH RADIATION AREA", and "GRAVE DANGER, VERY HIGH RADIATION AREA", respectively.

5.2.4. All equipment contaminated with radioactive material shall be marked with signs, decals, or other conspicuous means. Labeling shall not be required for laboratory containers

such as beakers, flasks, and test tubes, used in transiently in laboratory procedures during the presence of the user.

5.2.5. Prior to removal or disposal of an empty container, including shipping boxes, confirm that it is free of contamination and remove or deface any radioactive material label and other markings referencing radioactive materials.

5.3. **Shielding of Sources:** EHS will check during periodic surveys to ensure that adequate shielding is used in all radiological operations. The total amount of shielding materials that will be necessary will depend on the amount of activity and the type of radiation involved. In some instances, it may be necessary to construct a "hot cell" or large shielding barrier to meet shielding requirements. EHS will be available for consultation on all shielding problems encountered.

5.4. Aerosols, Dusts and Gaseous Products

5.4.1. Procedures involving aerosols, dusts or gaseous products or procedures which might produce airborne contamination in excess of regulatory limits shall be conducted in a hood, dry box or other suitable closed system. These procedures must be authorized in advance.

5.4.2. All release from such systems shall not exceed ten percent of the maximum permissible concentration in air for nuclide in question, unless regulated by a DEC Part 380 permit. However, where practical, traps should be incorporated in the experimental set-up to ensure that environmental releases are as low as possible.

5.4.3. Radioactive gases must be stored in gas-tight containers and must be kept in areas having approved ventilation.

5.4.4. Hoods to be used for radioisotope work shall be tested by EHS to ensure that they meet the minimum requirements for air velocity at the face of the hood.

5.5. **Work Surfaces:** All areas where radioactive material is used or stored shall be covered at all times with plastic-backed absorbent paper (e.g. "Kimpak"), stainless steel or plastic trays, uncracked glass plates or other impervious material. Absorbent paper should be replaced when damaged.

5.6. **Periodic Surveys of Radiation Areas:** Areas (e.g., hoods, bench tops) in which radioactive materials are being used should be checked for contamination as soon as each procedure is completed by the radiation workers in that laboratory. These areas shall be inspected each and every time there is a reason to suspect contamination; these surveys do not have to be recorded but action (i.e. decontamination) is required if limits are exceeded. Monthly wipe and instrument surveys must be conducted with recorded positive and negative survey results in the permit holders' laboratory logs.

5.7. **Laboratory Monitors:** Each laboratory or area (other than those where only H-3 is used) shall be equipped with a calibrated, functioning portable or semi-portable survey instrument to be used for personnel and area monitoring.

5.8. Removal of Equipment from the Laboratory: Once used for radioactive substances, equipment shall not be used for other work or sent from the area to cleaning facilities, repair shops, or returned to the source of supply, until a meter and wipe survey have been completed and contamination levels are under 100 dpm/100cm². The survey shall be recorded and record kept with other lab survey records. A "Terminal Survey Notice" from EHS Radiation Safety, stating that the equipment has been demonstrated to be free of contamination shall accompany the equipment.

5.9. Maintenance of Laboratories and Equipment: Laboratories or equipment to be serviced in the lab by shop, maintenance or custodial personnel, or by commercial contractors, shall be demonstrated (METER AND/OR WIPES) to be free of contamination (i.e. less than 100 dpm/100cm²) prior to servicing. The survey shall be recorded and record kept with other lab survey records. If necessity requires that emergency repairs be performed in contaminated areas, or on contaminated equipment, the work will be supervised by a member of EHS staff, who will assure that the necessary safeguards are taken. Laboratory personnel are responsible for requesting this supervision from EHS.

Prior to facility repair or maintenance (e.g. floor refinishing, leak repairs, etc.), the lab shall perform and record a meter and wipe survey of the affected area(s).

5.10. House Vacuum Lines: House vacuum lines are vulnerable to contamination. If house vacuum lines are to be used, the withdrawn gas must be free of radioactivity. Use a separate vacuum system whenever possible, such as separate vacuum pump exhausting into a hood.

5.11. Shared Facilities: Shared facilities host researchers from all over campus (and the world) to support a variety of experiments with specialized equipment. Examples include the Cornell Center for Materials Research, the Cornell NanoScale Science & Technology Facility, the Department of Chemistry and Chemical Biology's X-ray Diffraction Facility, and the Cornell High-Energy Synchrotron Source. Radioactive materials may not be used in shared facilities unless it has been reviewed by the Radiation Safety Committee and approved on the permit.

5.11.1. Shared facility safety protocols must be detailed in the PI's permit application and must also be approved by the shared facility manager. The shared facility will not be required to have its own permit.

5.11.2. Work involving significant potential for contamination will not be approved in shared facilities (e.g. complex dry operations, generation of aerosols, evaporating to dryness, in-vivo work, volatile components, quantities exceeding 10 times Part 16 Table 9 values)

5.11.3. In general, permanent "Radioactive Materials" warning signage is not required to be posted outside of the facility.

5.11.4. For work identified as potentially causing exposures or surface contamination exceeding public limits, rad worker is required to restrict area:

5.11.4.1. Worker must constantly attend sources of radiation and personally restrict access to area, or

5.11.4.2. Post conspicuous "Warning: Radioactive Materials" signage restricting access to the area for the duration of the work. Signage must also identify the worker and include emergency contact information.

5.11.5. A radiation/contamination survey must be documented before releasing the area for unrestricted use. The survey documentation is to be filed locally in the facility in the interest of transparency to other users, and for inspection by EHS.

5.12. People and Entities Not Affiliated with Cornell: Many third parties on campus are not legally affiliated with Cornell. For example:

- Technology Incubators on campus assist start-up and early development businesses by providing workspaces, access to shared facilities, and business support services.
- Visiting scientists use university research facilities.

New York State regulations and Cornell's radioactive material license explicitly forbid Cornell's licensed material from being used or stored by another firm or its employees, unless the firm possesses its own radioactive material license. All radioactive material and ionizing radiation on campus is subject to Cornell Radiation Safety Committee oversight. Radioactive material governed by Cornell's license must not be transferred to, used, or stored by people or entities that are not legally affiliated with Cornell without advanced authorization by the RSO.

Chapter 6: Acquisition of Radioactive Material and Sealed Sources

Acquisition of radioactive materials by direct purchase shall be completed in a manner so as to ensure compliance with the terms and conditions of the radioactive materials license issued to Cornell University by the NYSDOH. This chapter specifies the process by which both unsealed and sealed sources shall be purchased. For acquisitions of radioactive material by means other than by purchase, see section 6.5. See Chapter 4 for purchase, transfer or disposition of RPE.

Procurement Cards may not be used when ordering any radioactive materials.

All orders intended for delivery to any University facility, excluding the Boyce Thompson Institute (see section 6.3), must be placed through the Office for Supply Management Services (SMS) through e-shop for vendors listed or by submitting an "I Want" document if the vendor is not listed.

6.1. Orders for Unsealed Material: All radioactive material orders are sent to EHS by SMS for approval before a PO # is assigned.

6.1.1. eShop – Cornell's e-procurement system (e-Shop) is the preferred method for ordering standard, catalog radioactive materials. e-Shop will identify radioisotopes and route requisitions to EHS for prior approvals before the order is issued to the supplier.

Procurement cards may NOT be used in e-Shop. Only standard catalog items may be purchased through e-Shop; non-catalog and special orders not listed in the supplier's electronic catalog must be purchased by submitting an "I Want" document.

For shipments to the Ithaca Campus, the address for EHS shall be used as the "FINAL SHIP TO" address. In e-Shop use building code 2921. Use this format:

**Cornell University
Environmental Health & Safety
395 Pine Tree Road, Suite 210
Ithaca, NY 14850**

ATTN. - *name of permit holder* (Note: Do not use PI's building name)

For shipments to the Geneva campus and other off-campus Cornell facilities, the address of the individual permit holder must be used and must have prior approval by EHS.

6.1.2. **Non-confirming orders:** To have an order placed by SMS, submit a requisition as usual. State that the order is for radioactive material and indicate the name of the permit holder, the radionuclide and activity, and the "SHIP TO" address specified in section 6.1.1.

6.1.3. **Confirming orders:** In order to receive a P.O. number so that the permit holder or department may place a telephone order directly to the vendor, this process must be followed:

6.1.3.1. The authorized telephoner (authorized by a condition of the permit) phones SMS stating the desire to place an order for radioactive materials and providing the names of the telephoner, permit holder and vendor and the radionuclide and activity.

6.1.3.2. A purchase order number will be assigned and given to the telephoner. The telephoner may place the order with the vendor.

6.1.3.3. The order must be placed with the "SHIP TO" address specified in section 6.1.1.

6.2. Sealed source orders

6.2.1. Prior consultation with the RSO is required to acquire radioactive material in sealed form. A permit or registration, or an amendment to an existing permit or registration, is required in advance. See Chapter 7 for information regarding sealed source permits and registrations. Requests for acquisitions to either the SMS or the provider/vendor without the prior approval of the RSO will be denied.

6.2.2. SMS will not issue a P.O. number for the purchase of a sealed source unless the purchase requisition is approved by the RSO.

6.3. Boyce Thompson Institute Orders: Permit holders at the Boyce Thompson Institute, are exempt from utilizing the services of the University purchasing system. Orders for the purchase of radioactive materials shall be screened internally by the Institute's purchasing agent using copies of permits issued to the Institute's principal investigators as reference. All requirements in this chapter shall apply with the exception of sections 6.1.3.1 and 6.1.3.2.

6.4. Receiving and Distribution: All shipments of radioactive materials slated for the Ithaca campus, including the Boyce Thompson Institute, shall be delivered to EHS. For this reason the "SHIP TO" address as shown in section 6.1.1 must be used for all acquisitions. Upon receipt, shipments will be opened, surveyed for radioactive contamination, inventoried, and delivered to the permit holder for whom it is intended.

Shipments received directly to the laboratory or building receiving room, must be reported to EHS immediately. EHS will either advise the permit holder to turn over the shipment for processing by EHS or provide instruction for processing in the laboratory.

6.5. Other Acquisitions: For acquisitions from outside of Cornell, by means other than by purchase, (i.e. transfers, gifts, etc.), the RSO must be notified during the planning stage. See Chapter 9 for details.

For unusual situations, alternate shipping arrangements can be approved on a case-by-case basis by the RSO. Consult with the RSO to discuss these arrangements.

Chapter 7: Sealed Radioactive Sources

The possession and use of sealed radioactive sources at Cornell is authorized by a radioactive materials license issued by the NYSDOH. As required by the license, the use of sealed sources is restricted to specific individuals and locations authorized by the University RSC. This requirement applies to all radioactive material, including generally licensed and exempt quantity material.

Possession and use of sealed sources at Cornell requires a formal written authorization issued by the RSC in the form of a permit. Applications for permits are reviewed by the RSO before being submitted to the RSC.

7.1. General Requirements

7.1.1. Sealed Source Permits: The RSC is responsible for ensuring that sealed sources are used safely and in compliance with ALARA. A permit or registration must be obtained from the RSC in advance of any use or acquisition (by purchase, transfer, or otherwise) of sealed sources.

The application describes the isotope(s), amount(s), facilities, experimental procedures, hazards, handling precautions and the qualifications of the applicant. Depending on the degree of hazard and risk either a permit or a registration application is completed. The content of the application is tailored to reflect the degree of risk posed by the sealed source.

7.1.1.1. Qualifications: In order to qualify for a permit, an applicant must be a member of the Cornell faculty or qualified staff approved by the unit leader. Other individuals wishing to utilize radioisotopes must work under the supervision of a permit holder. The training and experience required to be granted a permit depend on the type and relative hazards associated with the sealed source to be used, and on the manner in which it will be used. In general, a permit applicant will be expected to have previous training and experience with similar sealed source and be able to demonstrate adequate knowledge of:

7.1.1.1.1. Radiation measurements, standardization, monitoring techniques, and instrumentation.

7.1.1.1.2. Mathematics and calculation techniques basic to the use of radioactivity.

7.1.1.1.3. The biological effects of radiation.

7.1.1.1.4. Emergency procedures.

This knowledge is obtained through required radiation safety training provided by the RSO and from training and/or experience received prior to Cornell.

If a faculty member or senior research associate does not have adequate qualifications to be granted a permit, additional experience can be gained by working under the supervision of a more experienced colleague who is a permit holder. When the

experience gained is sufficient to work independently, the application will be considered.

7.1.1.2. Process: To become a permit holder, an individual contacts the RSO and indicates a need to use sealed radioactive materials. The RSO meets with the individual to discuss the Cornell radiation safety program, the duties and responsibilities of a permit holder, and the application form and process. When completed, the permit application is submitted to the RSO who reviews it for completeness and then is submitted to the RSC. A subcommittee of the RSC reviews the application and visits the laboratory or other use location to discuss the application with the applicant and to review the adequacy of the facilities. The subcommittee will either approve the application or return it to the applicant for revision.

7.1.1.3. Permit Issuance: When an application is approved, the applicant will receive a written copy of the permit. On occasion, the RSC may impose restrictions on the use of the equipment if warranted for radiation safety and ALARA reasons. These will be stated in the permit.

Permits are issued for periods of two years. Permit holders will be notified in advance of the date that the permit is due to expire, however, permit holders are responsible for having a current permit in effect at all times. The permit holder may choose to terminate the permit or submit a request for renewal. The renewal request should specify any needed changes.

Between renewals, the permit holder may submit to the RSO written requests for amendments to the permit. The RSO will assist the permit holder as needed to provide the appropriate information. The chair of the RSC will review the request and may at his/her discretion approve it or forward it first to a subcommittee for review.

When a permit holder is expected to be away for up to six (6) weeks, the Alternate Contact (AC) will be in charge of the laboratory on behalf of the permit holder. The AC will be contacted for permit related issues and will perform most of the permit holder responsibilities and functions including minor requests for permit amendments such as adding/deleting users or rooms. The permit holder will, upon return, countersign all those items which required signatures during the absence. When the permit holder and the AC are expected to be away at the same time, the permit holder must advise the RSO so that an alternate arrangement can be made.

When a permit holder is expected to be away from Cornell for six (6) weeks or more, the permit holder and RSO will select a substitute permit holder who has the knowledge and expertise to be responsible for the laboratory. The substitute permit holder must agree in writing to accept the responsibility for the permit during the leave. A permit amendment will be issued to reflect the change.

7.1.1.4. Permit Termination: When termination of a permit is desired, the permit holder must notify the RSO as far in advance as possible. This is particularly important when

the termination is due to the permit holder's leaving the University. The permit holder will assist the RSO to ensure that:

7.1.1.4.1. All sealed sources still in the possession of the permit holder are properly transferred or disposed of.

7.1.1.4.2. Area/ personnel monitoring is discontinued, where applicable.

7.1.1.4.3. Postings and labels are removed from the authorized area.

7.1.1.4.4. Documentation of the transfer or disposal of any sealed source.

7.1.2. Sealed Source Registrations: Individuals who wish to use sealed sources that pose a very low risk to the user will be issued a Sealed Source Registration. Registrations are generally granted by the RSC chair, with recommendations from the RSO, without a RSC site evaluation. The following are examples of the kinds of sources or equipment that can generally be handled or operated without concern for dose to personnel:

7.1.2.1. Electron capture detectors (ECD)

7.1.2.2. Liquid Scintillation Counters (LSC)

7.1.2.3. Low activity calibration and check sources.

Sealed Source Registrations are issued for periods of two years. Registrants may be notified in advance of the date that the registration is due to expire, however, registrants are responsible for having a current registration in effect at all times. The registrant may choose to terminate the registration or submit a request for renewal. The renewal request should specify any needed changes.

7.1.3. New Facilities / Major Renovations: Plans and specifications for the construction of new radiation facilities, or the major modification of existing facilities, must be approved by the RSC. The information provided to the RSC must include, at a minimum, the technical specifications of the equipment, the facility layout, beam orientation, shielding (location and construction), occupancy of adjacent areas, and a summary of proposed operations, source use times, and expected radiation levels within and immediately outside controlled areas.

7.1.4. Acquisitions / Transfers / Movement / Disposal: All purchase requisitions and acquisitions must be reviewed and approved in advance by the RSO before the acquisition may proceed. See Chapter 6, Acquisition of Radioactive Material and Sealed Sources.

All transfers, movement, and disposal of sealed sources must be reviewed and approved in advance by the RSO. See Chapter 9, Transfer, Shipping, and Disposal of Radioactive Material and Sealed Sources.

7.1.5. Radiation Monitoring

7.1.5.1. Personnel dosimetry will be assigned as needed to meet the requirements of Chapter 8. When not required, the decision to use personnel monitoring is left to the discretion of the permit holder in consultation with the RSO.

7.1.5.2. Area dosimetry badges or monitoring equipment (e.g. GM meters) are required and must be used for all sealed sources of emitting a level of radiation greater than 0.5 mrem/hr at 5 cm from the surface. Dosimeters and GM meters are available from EHS.

7.1.6. **Personnel Dose Limits:** The University requires that radiation doses be maintained ALARA. Chapter 8 of this manual specifies the limits and guidelines for radiation workers, pregnant radiation workers, non-radiation workers and members of the public.

7.1.7. **Area Classification, Dose Limits & Identification:** Areas where personnel may be exposed to radiation are classified according to the dose rates listed in Table 7.1. The RSO, or designee, will determine controlled areas during a pre-operational survey. Only the RSO, or designee, may make changes in these designations.

7.1.7.1. **Noncontrolled Area:** An area to which **access** is neither controlled nor restricted.

7.1.7.2. **Controlled Area:** An area authorized for the use and/or possession of radiation sources where **access** is restricted to authorized radiation users and accompanied visitors.

7.1.7.2.1. Temporary access to high radiation areas is allowed only to qualified personnel with permission of the RSO and the department head. Personnel monitoring devices are required and portable survey instruments must be used during access to all such areas.

7.1.7.2.2. Portable radiation survey instruments must be available to personnel who work adjacent to radiation/high radiation areas.

7.1.7.2.3. Written safety operating procedures must be prepared by the permit holder and submitted to the RSO as part of the permit application. All area designations, safety procedures and precautions must be clearly spelled out. All qualified workers must be required to be familiar with the requirements of the procedure before starting work.

7.1.7.3. **Exclusion Area:** An area authorized for source use where access is strictly prohibited when the source is in use.

7.1.7.3.1. Continuously operating radiation monitoring devices must be installed in and adjacent to these areas. Such devices must provide an audible and visual warning to personnel in the vicinity when the preset maximum dose rate is exceeded.

Table 7.1: Classification of Areas and Dose Limits

Area	Dose Limits
<i>Noncontrolled Area</i>	Less than 2.0 mrem in 1 hour and less than 100 mrem in a year
<i>Controlled Area</i>	More than 2.0 mrem in 1 hour or more than 100 mrem in a year
<i>Radiation area</i>	More than 5.0 mrem in 1 hour @ 30 cm
<i>High Radiation Area</i>	More than 100 mrem in 1 hour @ 30 cm
<i>Exclusion Area</i>	Potential dose exceeds a high radiation area

7.1.8. Security/Access To Sources

7.1.8.1. All sealed sources must be secured against unauthorized operation when left unattended. When a sealed source is in use and unattended security may be accomplished by preventing access to the controlled area.

7.1.8.2. Certain sources with “quantities of concern” will have special security requirements. The RSO will indicate which sources are in this category.

7.1.9. Posting of Notices and Labeling: The following are required to be posted or present in controlled areas:

7.1.9.1. NY State Notice to Employee

7.1.9.2. Radiation Safety Manual (See Chapter 2, section 2.4.9)

7.1.9.3. A copy of the permit and application, or registration, all use procedures, and other safety documentation required by the permit or application

7.1.10. Inspections: The RSO, or designee, must perform an annual inspection and report the findings and recommendations to the permit holder. The permit holder must take steps to correct any violations upon receipt of such notice. Inspections are not required for sealed source registrations.

7.1.11. Violations

7.1.11.1. **Major:** Deviations from approved procedures which pose a potential for excessive radiation dose to personnel must be considered a major violation. Such activities must cease immediately and the RSO will be advised. The permit or registration holder must promptly correct the violation, and report to the RSO the corrective actions taken to prevent a recurrence. Follow up actions may be taken by the RSO in consultation, or under the direction, of the RSC.

7.1.11.2. **Minor:** Situations not posing a potential for excessive radiation dose to personnel, but violating any item of this chapter, must be designated minor violations. The permit or registration holder and RSO will be advised of the inspection findings. The permit or registration holder shall promptly correct the violation, and report within 30 days to the RSO the corrective actions taken to prevent a recurrence

7.1.12. **Exceptions:** Any exception to the requirements of this chapter must be applied for in writing and granted by the RSC upon demonstration by a permit holder that the requirement is unreasonable and that radiation safety can be maintained.

Chapter 8: Dose Limits, ALARA, and Dosimetry Requirements

Terminology:

- **Committed:** Used in determining internal exposures, referring to the dose being based on the amount which would be received over the following 50 years to account for doses received later in life from radionuclides still in the body.
- **Committed Dose Equivalent (CDE):** Dose to individual organs or tissues received over a 50 year period after a radioisotope is inhaled, ingested, or otherwise entered into the body
- **Committee Effective Dose Equivalent (CEDE):** Sum of doses to organs or tissues received over a 50 year period after a radioisotope is inhaled, ingested, or otherwise entered into the body weighted for its effect on the whole body
- **Deep Dose Equivalent (DDE):** The external whole-body exposure dose equivalent at a tissue depth of 1 cm.
- **Extremity:** Hand, elbow, arm below the elbow, foot, knee, and leg below the knee
- **Lens Dose Equivalent (LDE):** External dose to the lens of the eye at a tissue depth of 0.3 cm
- **Shallow Dose Equivalent (SDE):** External to the skin or an extremity at a tissue depth of 0.007 cm averaged over a 1 cm² area
- **Total Effective Dose Equivalent (TEDE):** Sum of doses received from external sources to the most highly exposed part of the whole body (DDE) and from radionuclides inside the body weighted for its effect on the whole body (CEDE)
- **Total Organ Dose Equivalent (TODE):** Sum of doses to individual organs or tissues from external sources (DDE) and from radionuclides inside the body (CDE)
- **Whole Body (WB):** Head, trunk (including male gonads), arms above the elbow, and legs above the knee

8.1. Dose Limits and ALARA: Cornell University follows the policy of keeping radiation exposures As Low As Reasonably Achievable (ALARA) as defined by 10 NYCRR 16.2(a)(11): *"As low as is reasonably achievable" (ALARA) means making every reasonable effort to maintain exposures to radiation as far below the dose limits in these regulations 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 economics 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.*

Anyone having control over a source of ionizing radiation is responsible for keeping personnel exposure to radiation ALARA. The Radiation Safety Committee maintains oversight and reviews measures to ensure conformance with the principles of ALARA by prescribing actions at the following measurement levels:

	Action level I (mrem/quarter)	Action level II (mrem/quarter)	Regulatory limit (mrem/yr)
<i>Whole body</i>	125	375	5,000
<i>Lens of the eye</i>	375	1,125	15,000
<i>Skin/extremity/organ</i>	1,250	3,750	50,000
<i>Minor</i>	10	30	100
<i>Fetus</i>	10	30	500

- No action is required for results below Level I.
- The Radiation Safety Group will review results exceeding Level I and report them at the next Radiation Safety Committee meeting. If an exposure does not exceed Level II, no specific action is required unless deemed appropriate by the Radiation Safety Officer or Radiation Safety Committee. Individual exposures will be considered in the context of others performing similar tasks.
- The Radiation Safety Group will investigate results exceeding Level II in a timely manner and may act to reduce exposures. Consideration will be given to cost and impact on operations. The results of Level II investigations will be presented to the Radiation Safety Committee.

8.2. Pregnant Radiation Workers: The manner in which the dose limits for the embryo/fetus is handled is at discretion of the pregnant radiation worker. Pregnant radiation workers are encouraged to advise their permit holder and the RSO of any situation that could result in fetal radiation exposure, so that the adequacy of radiation safety precautions can be assessed and pertinent information can be provided to the worker. Information and counseling may be requested at any time from the RSO. Counsel from a reproductive health specialist may be requested (because it is believed that the period of greatest radiation sensitivity for a fetus is from weeks 10 to 17, this assessment should be done as soon as possible.) Four options are available to pregnant radiation workers.

8.2.1. Pregnant workers may choose to officially declare their pregnancy, which restricts the dose to the embryo/fetus to 500 mrem during the gestation period. This could result in restrictions in the types of work the declared pregnant worker is allowed to perform. To declare a pregnancy, the worker must submit to her permit holder a "Declaration of Pregnancy" form (available from the RSO) or any other written declaration that states her approximate date of conception and that she wishes to be treated as a pregnant radiation worker for purposes of this section. Declarations of pregnancy may be made at any time during the pregnancy.

8.2.2. Pregnant workers may choose not to declare their pregnancy. If a pregnant worker does not declare her pregnancy, according to NYSDOH regulations, the dose restriction of 500 mrem to the embryo/fetus does not apply, (i.e. the embryo/fetus could have the potential to legally receive a total effective dose equivalent (TEDE) up to 5,000 mrem). If a worker decides not to declare her pregnancy, no restrictions in the types of work she may perform can be imposed based on her pregnancy. The option not to declare is to protect the

worker from possible discrimination due to restrictions in work activity. Until a worker officially declares a pregnancy, Cornell University, by law, must assume she is not pregnant.

8.2.3. A radiation worker may declare herself pregnant when, in good faith, she believes there is a potential that she may be pregnant, but her pregnancy has not been confirmed, by following the same procedure for declaring a pregnancy. When the radiation worker has confirmed her pregnancy, she must notify her permit holder and provide any revised estimated date of conception. A declaration of pregnancy will expire ten months after the declared estimated date of conception, unless it has been revised.

8.2.4. A radiation worker who has previously declared herself pregnant may revoke the declaration of pregnancy at any time, in her sole discretion. Since declaration of pregnancy will expire ten months after the declared estimated date of conception, the radiation worker need not revoke her declaration after the expiration date.

Every effort shall be made to avoid substantial variation above a uniform monthly dose rate to a declared pregnant woman. If at the time of declaration, the dose to the embryo/fetus has exceeded 450 mrem since the estimated date of conception, the embryo/fetus will be limited to a dose of no more than 50 mrem for the remainder of the pregnancy. The declared pregnant radiation worker must be required to wear a radiation badge in the abdominal region to evaluate doses to the embryo/fetus separately from the doses to the chest. The fetal badge must be worn under any protective clothing and the badging frequency shall be monthly.

It is important for pregnant workers to understand that fetal dose from any beta emitters, including P-32, will be zero from all external exposures. The only way to expose the fetus is through radioactive material taken into the body (internal contamination), or from exposure to photon sources (gamma or x-rays) or neutron sources.

8.3. Radiation Dosimetry Requirements: Individuals involved in the following activities must wear the prescribed monitoring equipment, such as badges and rings, as required by the provisions listed below:

8.3.1. Badge requirements for ensuring that doses are maintained ALARA for anyone handling radioactive materials, sealed or unsealed, are the following:

8.3.1.1. Users of beta emitters with energies less than 200 keV are not required to wear badges, because these energies are too low to be measured by these devices.

8.3.1.2. Users of beta emitters with energies greater than or equal to 200 keV and an activity of 1 mCi or greater must wear a whole body badge and a ring badge on each hand.

8.3.1.3. Users of any gamma emitter with an activity of 1 mCi or greater shall wear a whole body badge and a ring badge on each hand.

8.3.2. Users of RPE must wear badges for ensuring that doses are maintained ALARA under the following conditions:

8.3.2.1. Operators and users of X-ray diffraction equipment used in an open beam configuration must wear a whole body badge and ring badges.

8.3.2.2. Individuals who work near accelerators who could be exposed to a dose rate in excess of 2.0 mrem/h must wear a whole body badge.

8.3.2.3. Individuals who remain in the room during the use of radiographic equipment must wear a whole body badge.

8.3.3. Any individual who performs veterinary fluoroscopic procedures must wear a whole body badge and a ring badge on each hand in compliance with NYS DOH regulation.

8.3.4. Any individual who holds animals or films during veterinary radiography must wear a whole body badge in compliance with NYS DOH regulation.

8.3.5. Anyone working in areas greater than 2.0 mrem/h must wear a whole body badge to ensure that doses are maintained ALARA.

8.3.6. Any individual entering high or very high radiation areas must wear a whole body badge for compliance with NYS DOH regulation.

8.3.7. Any individual who is likely to receive an external dose in excess of ten percent of the applicable "Maximum Permissible Dose" specified in section 8.2 of this chapter must wear badges appropriate to the type of dose for compliance with NYS DOH regulation.

8.3.8. Individuals who do not fall within these categories may be issued a whole body badge or both a whole body badge and a ring badge for each hand upon request. Ring badges will not be issued without a body badge, and rings will always be issued in pairs.

A body badge is used with rings in the event some work is not done behind a beta shield or contaminated equip needs to be cleaned. Also, the body limit is lower than the hand dose limit so it is possible that the body limit could be exceeded before the hand limit.

8.3.9. Monitoring frequency, normally two-month periods, must be at the discretion of the RSO.

8.3.10. Badges, except visitor badges, issued for any reason, whether required or requested, must be worn whenever a possibility for exposure exists, i.e. whenever near any source of radiation.

8.3.11. The RSO may modify the requirements above based on potential exposure assessments and the likelihood of actual exposures. For example, the use of extensive body and finger shielding with high activity P-32 may result in very low actual exposures. In this case dosimetry may not be needed.

8.4. Radiation Dosimetry Records

8.4.1. Access to an individual's dose records must be restricted to that individual and to individuals with responsibility for ensuring radiation safety at the University. These individuals include the RSO, the RSC members, the badged individual's permit holder, department safety officer, principal investigator, and/or supervisor and their designees. Access to other parties may be granted only with written authorization from the badged individual.

8.4.2. Doses for each calendar year will be made available online to each badged individual. Except when required by a regulatory agency, individuals who leave Cornell prior to receiving the report have the option to receive one if they provide a forwarding address to the RSO. Except when required by a regulatory agency, visitors will not be sent a report unless one is specifically requested in writing to the RSO.

8.4.3. Individuals may obtain their dose records at any time upon written request to the RSO.

8.4.4. Individuals who have been monitored previously at other institutions must provide a cumulative record of previous radiation exposure to the RSO or authorization (including an address) for the RSO to request those results from the other institution.

8.4.5. Individuals monitored at other institutions during the current calendar year must provide the radiation exposure results from the other institution in writing to the RSO as soon as they are available.

Chapter 9: Transfer, shipping, and disposal of radioactive material and sealed sources

9.1. Definitions

9.1.1. Transfer - the change of ownership of radioactive material between permit holders or registrants.

9.1.2. Movement - relocation of radioactive material between labs and/or buildings.

9.1.3. Shipment - when radioactive materials are moved to another location via motorized vehicle or motor carrier.

9.1.4. For transfer, movement or shipment of RPE see Chapter 4, section 4.1.3.

9.2. Transfer of Radioactive Material: The Radiation Safety Officer must approve transfers in advance, to ensure the receiving permit holder is authorized to receive it. The transaction must be documented on the provider's inventory log sheet, and EHS will provide a new inventory sheet to the receiver.

9.3. Shipping of Radioactive Material: All radioactive material being transported via a motor vehicle must be in compliance with state and federal regulations. No radioactive material may be shipped from Cornell University except by the RSO.

Because the RSO handles all authorizations, communications, packaging and transportation for the permit holder, permit holders are relieved of the responsibility for understanding and complying with transportation regulations. Contact EHS in advance to arrange for shipments.

9.4. Disposal of Radioactive Material: Federal, State, and Cornell regulations related to radioactive waste and shipping change frequently. The RSO implements these changes as they occur. This section specifies the Cornell waste disposal policies which govern the radioactive waste program. The procedure for implementing these policies is located in the "Procedure for Disposal of Radioactive Materials" located in the Waste Disposal section at the end of this manual.

9.4.1. Disposal may only be carried out by the RSO.

9.4.2. Disposal may not be carried out by ordinary means.

9.4.3. No radioactive materials may be deposited into the regular trash.

9.4.4. Disposal of radioactive liquids in the sanitary sewer (i.e. down the sink) is not permitted unless authorized in writing by the RSO as a special condition of the permit holder's Radioactive Materials Permit. Dispose of waste in a timely manner not to exceed 2 years from the time the last waste of that type was generated, or whenever the waste container is full.

9.4.5. Follow all instructions given in the "Procedure for Disposal of Radioactive Materials" referenced above. Adherence to these rules will ensure compliance.

Chapter 10: Emergencies

10.1. **Preventive Measures:** Most accidents involving radioactive materials can be avoided if the recommended procedures for safe handling are followed by all laboratory personnel. New procedures must be approved in advance by the permit holder. If the permit holder determines that the new work does not fall within the scope of work described in the permit, a permit amendment must be obtained before the work may be performed. Trial runs without radioactive material (non-isotope runs) are encouraged for new procedures where there is the potential for an individual to receive a significant radiation dose.

The use of lab coats, disposable gloves (recommend 2 pairs be used), and eye protection is mandatory whenever unsealed radioactive materials are handled. Workers must be thoroughly familiar with the emergency procedures and the location of telephones, exits, and all available safety devices.

10.1.1. **Spills:** Where danger of spills of radioactive solutions exists, secondary pans and trays must be used. Cover containers whenever possible, and only those amounts of radioactive solutions that are immediately necessary should be drawn from stock. Double containers, tightly gasketed, and with chemically inert absorbers, should be used for transporting radioactive solutions if spillage will create a hazardous condition. When feasible, radioactive solutions should be stored in similar containers. Laboratory benches or hoods where spills may occur should not drain to the sewer.

10.1.2. **Air Contamination - Dusts, Mists, Fumes, Organic Vapors, and Gases:** Procedures must be reviewed for their potential to generate air contamination. Procedures should be designed to prevent air contamination, if possible. Adequate mechanical ventilation is a necessary precaution when air contamination could result from either routine or accident conditions. Floors of hoods, and glove boxes should be covered with disposable plastic backed absorbent paper to catch dust, spray, or condensate. Radioactive gases and volatile materials, whether in the laboratory or in storage areas, should always be kept in gasketed, gas tight containers.

10.1.3. **Fires and Other Major Emergencies:** If possible, all radioactive materials in the laboratory not immediately in use should be stored in a manner that will safeguard against possible accidental spread of radioactive contamination in the event of a major disaster.

10.2. Emergency Procedures

10.2.1. Minor Spills Involving No Radiation Hazard to Personnel

10.2.1.1. Notify all other persons in the room at once.

10.2.1.2. Permit only the minimum number of persons necessary to deal with the spill into the area.

10.2.1.3. Confine the spill immediately.

Liquid Spills:

Don protective gloves.

Drop absorbent paper on spill.

Dry Spills:

Don protective gloves.

Dampen thoroughly, taking care not to spread contamination.

10.2.1.4. Decontaminate

10.2.1.5. Monitor all persons involved in the spill and cleanup.

10.2.1.6. Permit no person to resume work in the area until a wipe and instrument survey is performed.

10.2.1.7. Phone the Cornell Police at 255-1111 to report the accident if assistance is desired. (See section 10.2.2.7 of this Chapter)

10.2.1.8. Review the cause of the accident to learn of preventative measures.

10.2.2. Major Spills Involving Radiation Hazard to Personnel

10.2.2.1. Notify all persons not involved in the spill to vacate the room at once.

10.2.2.2. If the spill is liquid and the hands are protected, right the container.

10.2.2.3. If the spill is on the skin, flush thoroughly.

10.2.2.4. If the spill is on clothing, discard outer or protective clothing at once.

10.2.2.5. Switch off all fans.

10.2.2.6. Vacate the room.

10.2.2.7. Phone the Cornell Police at 255-1111 to report the accident. The HazMat team will respond and assess the need for implementation of the Incident Command System (ICS). The incident commander will consult with the radiation safety team to determine the appropriate action(s) to take.

10.2.2.8. Take immediate steps to decontaminate personnel involved, as necessary.

10.2.2.9. Decontaminate the area. (Personnel involved in decontamination must be adequately protected.)

10.2.2.10. Monitor all persons involved in the spill and cleaning to determine adequacy of decontamination.

10.2.2.11. Permit no person to resume work in the area until a survey is made.

10.2.2.12. Prepare a complete history of the accident and subsequent activity related thereto for the necessary records.

10.2.3. Accidents Involving Radioactive Dusts, Mists, Fumes, Organic Vapors and Gases

10.2.3.1. Notify all other persons to vacate the room immediately.

10.2.3.2. Hold breath and close escape valves, switch off air circulating devices, etc., if time permits.

10.2.3.3. Vacate the room.

10.2.3.4. Notify the Cornell Police at 255-1111 at once to report the accident. (See section 10.2.2.7 of this Chapter)

10.2.3.5. Ascertain that all doors giving access to the room are closed. Post conspicuous warning or guards to prevent accidental opening of doors.

10.2.3.6. Report at once all known or suspected inhalations of radioactive materials to Cornell Police at 911. (See section 10.2.2.7 of this Chapter)

10.2.3.7. Evaluate the hazard and the necessary safety devices for safe reentry.

10.2.3.8. Determine the cause of contamination and rectify the condition.

10.2.3.9. Decontaminate the area.

10.2.3.10. Perform air survey of the area before permitting work to be resumed.

10.2.3.11. Monitor all persons suspected of contamination.

10.2.3.12. Prepare a complete history of the accident and subsequent activity related thereto for the necessary records.

10.2.4. Injuries to Personnel Involving Radiation Hazard

10.2.4.1. Wash minor wounds immediately, under running water, while spreading the edges of the gash.

10.2.4.2. Report all radiation accidents to personnel (wounds, over-exposure, ingestion, inhalation) to the Cornell Police at 911 as soon as possible. (See section 10.2.2.7 of this Chapter).

10.2.4.3. A physician will be contacted if necessary. The RSO will decide if special treatment is required.

10.2.4.4. Permit no person involved in a radiation injury to return to work without the approval of the attendant physician.

10.2.4.5. Prepare a complete history of the accident and subsequent activity related thereto for the necessary records.

10.2.5. Fires or Other Major Emergencies

10.2.5.1. Alert all personnel in immediate danger.

10.2.5.2. Report the fire immediately regardless of size to the Cornell Police at 911. Tell the dispatcher the building involved, the floor, the kind of fire, the lab is used for radioactive materials, your name and extension number. (See section 10.2.2.7 of this Chapter)

10.2.5.3. Try to put out manageable fires. If fire not manageable, leave the area immediately, close the door, wait for arrival of firefighters.

10.2.5.4. The HazMat team will respond and assess the need for implementation of the Incident Command System (ICS). The incident commander will consult with the radiation safety team to determine the appropriate action(s) to take.

10.2.5.5. Following the emergency, monitor the area to determine whether or not decontamination is required. If decontamination is necessary, determine the protective devices necessary for safe decontamination.

10.2.5.6. Decontaminate.

10.2.5.7. Permit no person to resume work until a radiation survey has been completed and the area shown to be safe.

10.2.5.8. Monitor all persons involved in responding to the emergency.

10.2.5.9. Prepare a complete history of the emergency and subsequent activity related thereto for the necessary records.

10.2.6. Decontaminating Personnel

10.2.6.1. Treat life threatening and/or major injuries first.

10.2.6.2. If clothing is contaminated, remove any contaminated items. This reduces the exposure to the skin and minimizes the spread of contamination.

10.2.6.3. Survey the contaminated area quickly to assess the initial general level of contamination.

10.2.6.4. Begin washing the affected area(s) gently using only mild soap and water. Wash in a sink, if available, or over a bucket to collect wash water. Do not scrub with a brush or any abrasive. For small areas (e.g. finger tips or small spots of contamination), try using wet paper towels to gently wipe the area first and then move to washing in a sink if needed.

10.2.6.5. After about a minute, stop and re-survey to check for the reduction in contamination levels.

10.2.6.6. Repeat steps 10.2.6.4 and 10.2.6.5 as long as contamination levels are being reduced or the skin starts to become irritated. Cleaning should stop at this point to prevent any remaining contamination from penetrating deeper into skin pores.

10.2.6.7. The radiation safety team will assess the level of remaining contamination and, in consultation with the contaminated person, will decide if further decontamination at Gannett Health Center should be done or if decontamination should stop and a dose be assigned to the individual.

Chapter 11: Notification of incidents

11.1. Each permit holder must report to the RSO the theft or loss of any source of radiation immediately after such occurrence becomes known.

11.2. Each permit holder must immediately notify the RSO of any incident involving any source of radiation which may have caused or threatens to cause:

11.2.1. A radiation exposure in excess of applicable limits to any individual

11.2.2. The release of radioactive materials which will cause excessive levels and concentrations of radionuclides in air or water.

11.3. Each permit holder of sources subject to increased security controls must notify the RSO of any of the following:

11.3.1. Actual or suspected attempts to break, bypass, circumvent, or disable all or any portion of the security system.

11.3.2. Actual or suspected attempts to remove sources, modify or remove shielding, or change any feature of the device or source.

11.3.3. Actual or suspected unauthorized attempts to obtain information about the source, security system, or security plans.

The RSO will relay all information to Cornell Police for further follow up and possible reporting to appropriate agencies.

Chapter 12: Violations of the radiation safety program

Every individual using ionizing radiation must abide by the applicable requirements of the Cornell Radiation Safety Manual and the conditions of the permit or registration issued by the RSC authorizing that use. In addition, the permit holder or registrant supervising the individual is responsible for the actions of the individual. The RSO is authorized by the RSC to respond to violations of these requirements and conditions as described below.

Violations are acts and omissions contrary to the Cornell radiation safety program. Accidents, even serious accidents, are not in themselves violations. Activities carried out in good faith compliance with the expectations of the radiation safety program will not be considered violations.

12.1. Improper handling of RAM with Imminent Potential Health Hazard: The primary consideration in the use of ionizing radiation at Cornell University must be to prevent excessive exposure of personnel to contamination and external radiation. The following examples are considered imminent health hazards.

- 12.1.1. Extensive laboratory contamination
- 12.1.2. Loss of significant quantities of radioactive material
- 12.1.3. Excessive radiation fields in unrestricted areas
- 12.1.4. Unsecured high health hazard radioactive stock material

If, in the opinion of the RSO, a violation creates an imminent hazard to human health, the RSO will take immediate and appropriate action to eliminate or control the hazard and will suspend further use of the material or equipment. Such action may include barring access to areas, removing radioactive material from a laboratory or locking out the power supplies to radiation producing equipment.

The suspension will remain in effect until the situation has been reviewed by the RSO and RSC. If warranted, an individual's authorization to use radiation sources and/or the permit or registration will be terminated. If termination is not warranted, the permit or registration may be suspended for an extended period and appropriate new conditions may be added to the permit or registration to prevent recurrence of the violation.

Every worker and supervisor has the responsibility to report to the RSO as soon as possible any situation that may pose an imminent health hazard and to assist the RSO with the evaluation and control of the situation.

12.2. Improper handling of RAM without Imminent Potential Health Hazard: The RSO will respond to violations that do not pose an imminent hazard to health with an initial emphasis on education about the issue and suggestions for corrective action. This category includes:

- 12.2.1. Failure to train and supervise workers
- 12.2.2. Use of radiation sources by unauthorized individuals
- 12.2.3. Failure to wear personal protective clothing

- 12.2.4. Unauthorized experimental procedures
- 12.2.5. Failure to perform radiation protection surveys
- 12.2.6. Survey or monitoring equipment unavailable or not operational
- 12.2.7. Elimination or bypassing of safety interlocks
- 12.2.8. Unsecured low health hazard radioactive stock material

First time violations will be brought to the attention of the Permit Holder or Registrant, in writing, by the EHS staff member discovering the violation. The Permit Holder or Registrant must respond to the notification in writing to indicate that the violation has been corrected, describe the corrective action taken, and specify how future occurrences will be prevented.

In some cases, the EHS staff member may require on going confirmation that the violation has been corrected. For example, for a failure to maintain adequate radiation protection survey records, the Permit Holder may be required to submit duplicate copies of the records to the staff member for several months.

For repeat violations, the RSO will require implementation of more rigorous procedures and greater personal supervision by the Permit Holder or Registrant. A violation from this category, one that may directly influence the radiation exposure of an individual, will be considered a "repeat violation" if it occurs twice within two years (5 consecutive inspections).

12.3. Non-handling violation: Other violations will be considered repeat violations if they occur twice within one year (three consecutive inspections). Examples of these violations include the following:

- 12.3.1. Inadequate radiation protection surveys
- 12.3.2. Inadequate radioactive material inventory and disposal records
- 12.3.3. Inadequate labeling of work areas, containers and storage areas

The RSO will bring a repeated violation to the attention of the Permit Holder and Department Head and will require a written response and/or actions that demonstrate that the current violations have been corrected and the Permit Holder understands how to avoid repeating the violation in the future.

The RSO may impose temporary restrictions on operations, require the development and implementation of new procedures or require the attendance of the individual, Permit Holder or Registrant at training and retraining programs presented by EHS.

When repeat violations continue to occur, the RSO will take the action deemed appropriate to obtain compliance, including modification, extended suspension or termination of the permit or registration. The RSO will advise both the Permit Holder or Registrant (and/or individual) and the Chair of the RSC of such action. The Permit Holder or Registrant (and/or individual) may request the RSC to review this action and consider alternate action.

12.4. Examples of Violations: Actions taken by the RSO in response to violations will vary according to the consequences, or potential consequences, of the violation and the past compliance history of the Permit Holder or Registrant.

Example 1: Failure to maintain proper survey records per Chapter 5 sec. 5.6 of the Radiation Safety Manual.

Areas (e.g., hoods, bench tops) in which radioactive materials are being used should be checked for contamination as soon as each procedure is completed by the radiation workers in that laboratory. These areas must be inspected each and every time there is reason to suspect contamination. Monthly wipe and instrument surveys must be conducted with recorded positive and negative survey results in the Permit Holders' laboratory logs.

1st violation: Memo from Permit Holder indicating that deficiencies in survey procedures and/or reports have been corrected and will not be repeated (current month's survey report attached to memo for review by EHS). Copy of monthly survey reports sent to EHS each of the next three months.

2nd violation: Permit holder required to attend retraining program on radiation protection surveys at EHS.

3rd violation: Authorization to purchase radioactive material suspended for 30 days and/or stock radioactive material impounded for 30 days. Also require copies of monthly survey reports mailed to EHS for each of the next six months.

Example 2: Failure to provide monthly inventory report per Chapter 2 sec 2.4.5.3 of the Radiation Safety Manual.

records indicating the receipt, dispensation, transfer and disposal of radioactive materials. An end of month inventory of radioactive materials must be reported to EHS

1st violation: Five day extension to provide report to EHS.

2nd violation: Suspend purchase of radioactive material and/or impound stock material until summary is provided

3rd violation: Suspend purchase of radioactive material 30 days and/or impound stock material for 30 days.

Example 3: Unauthorized transfer of radioactive material per Chapter 9 of the Radiation Safety Manual.

Transfer of materials between Permit Holders is sometimes permissible, but only with prior approval by the RSO.

1st violation: Memo from Permit Holder describing the isotope, activity and recipient involved in the transfer and indicating that unauthorized transfers will not be made in the future.

2nd violation: Permit holder required to develop detailed written procedure for transfer of radioactive material from the laboratory and to train laboratory staff to follow them.

3rd violation: Suspend purchase of radioactive material 30 days and/or impound stock material for 30 days.

Example 4: Failure to provide adequate instruction to workers per Chapter 2 sec 2.4.3 of the Radiation Safety Manual.

Ensuring that all individuals working in a restricted area have been instructed in the following:

1. *Procedures and precautions to minimize exposure.*
2. *Purpose and function of protective devices.*
3. *Reporting requirements (Ch. 11).*
4. *Responses to emergencies or malfunctions (Ch 10).*
5. *Availability of radiation exposure reports.*
6. *Health protection problems associated with radiation exposure.*

The extent of these instructions must be commensurate with potential radiological health protection problems.

1st violation: Memo from the Permit Holder or Registrant indicating that his or her responsibilities for instruction have been made clear and indicating the date by which all individuals working in restricted areas will have received this instruction.

2nd violation: Permit Holder or Registrant required to develop written training outline of topics and procedures relevant to radiation safety in the laboratory. The Permit Holder or Registrant required confirming that this information has been presented to all individuals working in restricted areas.

3rd violation: Suspend purchase of radioactive material 30 days and/or impound stock material for 30 days.

Example 5: Failure to provide or maintain appropriate monitoring or survey equipment per Chapter 2 sec 2.4.5.7 of the Radiation Safety Manual.

Making available the appropriate apparel, shielding and monitoring equipment to assure minimal exposure and contamination.

1st violation: Memo from Permit Holder or Registrant indicating that the requirements for monitoring and survey equipment are understood and have been met.

2nd violation: Permit Holder or Registrant required to attend retraining program on radiation protection surveys at EHS.

3rd violation: Authorization to purchase radioactive material suspended for 30 days and/or stock radioactive material impounded for 30 days or authorization to use radiation producing equipment suspended for 30 days. Permit Holders also required to mail copies of monthly survey reports to EHS for each of the next six months.

Example 6: Failure of worker to wear appropriate protective clothing per Chapter 2 sec 2.5.3.1 of the Radiation Safety Manual.

Wearing a lab coat and disposable gloves at a minimum whenever contamination is possible, and not wearing such articles outside of the laboratory area.

1st violation: Memo from Permit Holder indicating that the laboratory requires users to wear protective clothing whenever they are handling radioactive material.

2nd violation: Permit holder required to develop detailed written procedure for handling radioactive material in the laboratory, to train laboratory staff to follow them, and to post the procedures in every authorized isotope use room.

3rd violation: Suspend purchase of radioactive material 30 days and/or impound stock material for 30 days.