

UConn HEALTH

Radiation Safety Manual



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Statement of Authority

UConn Health is authorized to use byproduct radioactive materials under a broad scope license issued by the U.S. Nuclear Regulatory Commission (NRC). It is also authorized to use radiation-generating devices in accordance with Connecticut state regulations.

Continued use of radioactive materials and radiation generating devices is contingent upon the development and maintenance of a radiation safety program. The program is outlined in this Radiation Safety Manual. The program and manual are approved by the UConn Health Radiation Safety Committee (RSC).

The goal of the program is to ensure license and regulatory compliance while maintaining exposures as low as reasonably achievable (ALARA).

Purpose

This manual provides essential information and outlines or references various processes and procedures supporting the safe use of radioactive materials (RAM) and radiation generating devices (RGD) at UConn Health.

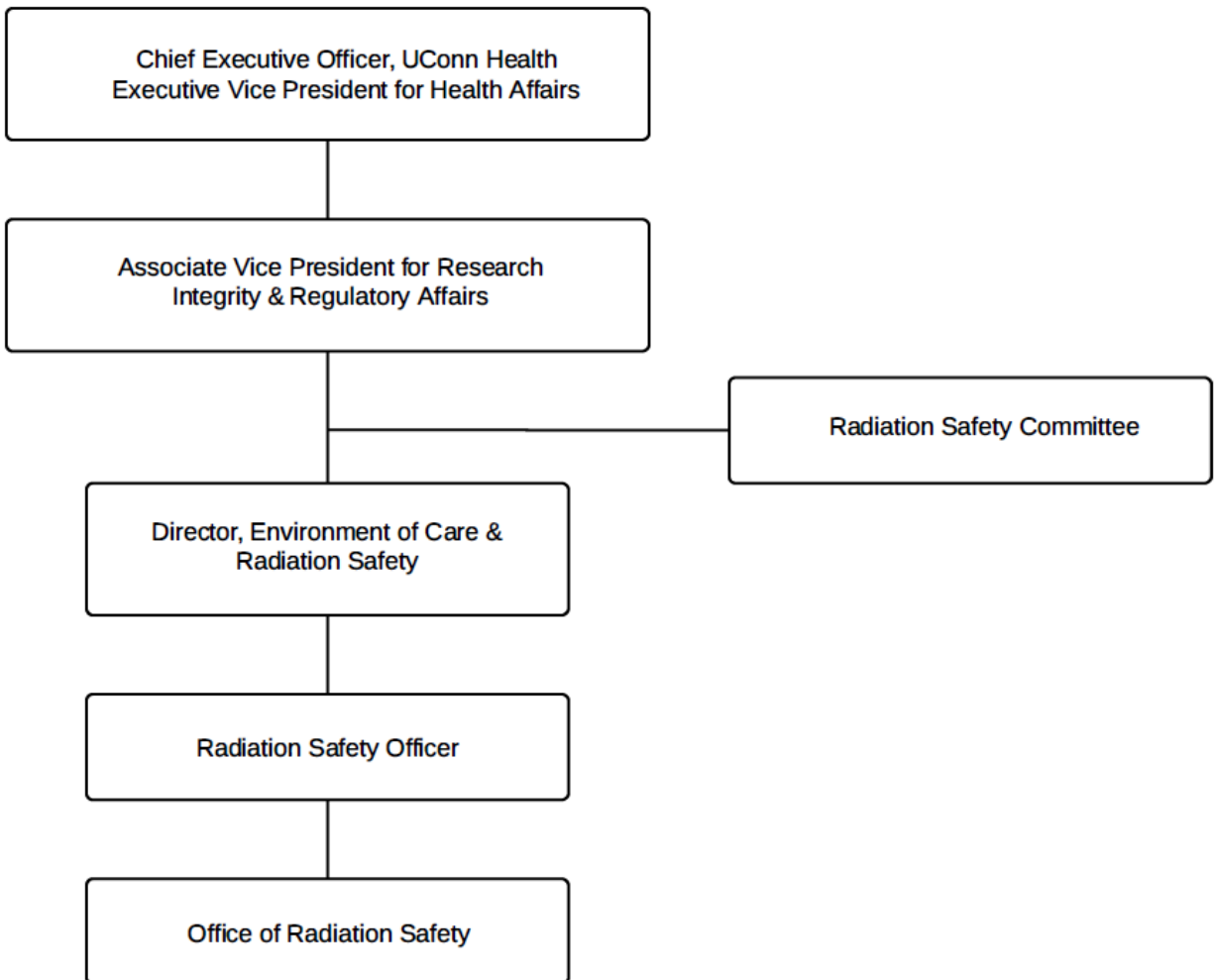
This manual also outlines the program for ensuring exposures are maintained ALARA.

Scope

The program and manual apply to the use of radioactive materials for research and medical purposes and to the use of ionizing radiation generating devices such as x-ray and Computed Tomography (CT) machines. This program does not apply to the use of non-ionizing radiation generating devices such as Magnetic Resonance Imaging (MRI) machines and clinical lasers.

Administrative Structure

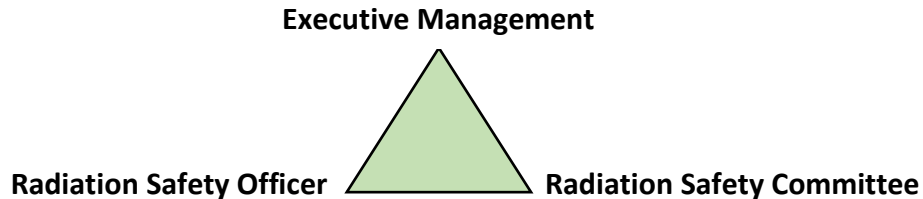
The administrative structure overseeing the radiation safety program is depicted in the following organizational chart.



Roles & Responsibilities

UConn Health uses the “Management Triangle” concept outlined in NUREG-1516.

Management is ultimately responsible but they rely heavily on the Radiation Safety Committee and Radiation Safety Officer to oversee regulatory compliance while maintaining exposures ALARA.



The individual representing executive management is the Chief Executive Officer. The RSC reports to the CEO through the management representative, the Associate Vice President for Research Integrity and Regulatory Affairs.

The Radiation Safety Committee (RSC) is the administrative body responsible for the safe use of ionizing radiation at UConn Health. Details regarding organization, membership, authority, roles, responsibilities, and operating procedures are outlined in the RSC Charter on the Office of Radiation Safety (ORS) website.

The Radiation Safety Officer (RSO) oversees implementation of the program and has the authority to stop work if he/she determines it to be in violation or in conflict with license, program, policy, procedure, regulatory requirement, or a safety concern. The RSO functionally reports to the RSC. Additional details regarding RSO roles and responsibilities are provided in Appendix 2, “RSO Roles & Responsibilities.”

Principal Investigators (PI) include any UConn Health faculty or professional staff member who has been authorized by the RSC to use or supervise the use of RAM for nonclinical, research purposes. They are responsible for the proper use, storage, and disposal of RAM and for ensuring all individual users working under their supervision comply with the requirements of this manual and any directives from the ORS. Personnel wishing to become a PI must contact ORS for information related to eligibility requirements, responsibilities, and application materials.

Individual Users (IU) are UConn Health personnel working under the direction of a PI for nonclinical research purposes. IUs are approved by PIs and require specialized training.

Authorized users (AU) are physicians who have been approved by the RSC to prescribe and/or direct the use of RAM for clinical purposes. Personnel wishing to become an AU must contact ORS for information related to eligibility requirements, responsibilities, and application materials.

Authorized Medical Physicists (AMP) include UConn Health or vendor personnel who have been approved by the RSC as meeting the requirements of 10 CFR 35.51 and 35.59. Personnel wishing to become an AMP must contact ORS for information related to eligibility requirements, responsibilities, and application materials.

Radiation workers include AUs, IUs, PIs, AMPs, plus all UConn Health employees, residents, and fellows who are occupationally exposed to radiation. All radiation workers are responsible for complying with the requirements of this manual.

Radiation Worker Rights

Per 10 CFR 19, Form 3 and/or State of Connecticut regulations, radiation workers have the following rights. These include:

- The right to access your exposure records
- The right to speak to the NRC, DPH, or other regulatory agency if you are worried about radiation safety or have other safety concerns with licensed activities such as the quality of construction or operations
- The right to request an NRC inspection if you believe UConn Health has not corrected violations involving radiological working conditions
- The right to bring questions and concerns to the RSO

With these rights come some responsibilities. These include:

- The responsibility to comply with the requirements of the radiation safety program
- The responsibility to properly wear and return dosimetry or transmit dosimetry data to ensure exposures are properly monitored
- The responsibility to wear PPE and use shielding whenever required to ensure exposures are maintained as low as reasonably achievable (ALARA)
- The responsibility to report accidents, incidents, regulatory non-compliance, or conditions which may result in unnecessary exposure, to the ORS or NRC
- The responsibility to respond to ORS requests for information in a timely manner

Failure to comply with these responsibilities may result in temporary or permanent removal of authorization to work with radioactive materials or radiation generating devices.

Training

The Office of Radiation Safety develops, implements, and oversees numerous training programs in support of the radiation safety program. Examples include:

- In person training for AUs, residents/fellows, and staff supporting radionuclide therapies
- Online (SABA) training for employees, radiation workers, fluoroscopy workers, and fluoroscopy equipment operators

- Training provided to physicians through the Medical Staffing Office
- Badge training for radiation workers

Refer to ORS GL-5, “Radiation Safety Training Program” located on the ORS website for additional information on the various training programs supporting radiation safety.

Monitoring of Occupational Exposure

UConn Health monitors radiation worker exposures and sets ALARA alert levels to comply with NRC and State of Connecticut exposure limits and to maintain exposures ALARA.

NRC exposure limits are summarized in the following table:

Area of Exposure	Dose Limit Per Year
Whole Body (Total Effective Dose Equivalent – TEDE)	5,000 mrem
Individual Organ or Tissue (Deep Dose Equivalent – DDE)	50,000 mrem
Lens of the Eye (Lens Dose Equivalent – LDE)	15,000 mrem
Skin or Extremity (Shallow Dose Equivalent – SDE)	50,000 mrem
Embryo/Fetus (Declared Pregnant Employee)	500 mrem *

*From time of declaration to revocation of declaration or end of pregnancy

State of Connecticut exposure limits are summarized in the following table:

Area of Exposure	Dose Limit Per Quarter
Whole body; head and trunk; active blood-forming organs; lens of eyes, or gonads	1,250 mrem
Hands and forearms; feet and ankles	18,750 mrem
Skin of whole body	7,500 mrem

To ensure exposures remain below State and Federal limits, ORS has established the following ALARA levels:

	ALARA Level I	ALARA Level II
Whole Body	500 mrem/year	1,500 mrem/year
Lens of Eye	1,250 mrem/year	4,500 mrem/year
Extremities	5,000 mrem/year	15,000 mrem/year

Exposures exceeding ALARA levels are reported to the RSC and investigated by the ORS to determine if actions are required to maintain exposures below state and federal limits. The RSO also reserves the right to investigate unusually high or low doses as needed to ensure proper monitoring, use of dosimetry, use of PPE, etc.

Vendors/contractors requesting access to areas of UConn Health that require the use of personal dosimetry shall provide their own. If that is not possible, ORS may supply temporary dosimetry.

One time and/or routine bioassays may be required (based on the amount of radioactive material and chemical compound used) to determine internal exposure (committed effective dose equivalent) and to calculate the total effective dose equivalent (TEDE).

Any individual using more than 100 millicuries of tritiated water (H-3), tritiated sodium borohydride, tritiated gas per experiment, or more than 10 millicuries of a H-3 labeled organic compound per experiment must have an assay performed within one week following a single operation. If these quantities are used on a regular basis, weekly bioassays are required.

Individuals using one or more millicuries of a volatile form of I-125, must have a thyroid bioassay performed within seven days if required by radiation safety. Personnel handling I-131 (in pill form) in nuclear medicine applications are not required to have thyroid bioassays unless they have reason to suspect they have been exposed. Exposure may occur if/when a patient bites a capsule, vomits immediately after swallowing a capsule, etc.

Radiation workers wishing to voluntarily declare themselves pregnant must do so in writing. Once a worker declares herself pregnant, ORS will schedule a confidential consult with the worker to discuss exposure history and review radiation safety strategies to minimize radiation exposures to worker and fetus. At this time, ORS will provide a fetal badge to be worn near the waistband to monitor fetal dose on a monthly basis. Details regarding declaration of pregnancy and fetal dose limits are provided in ORS SOP-1, "Declaration of Pregnancy."

Federal regulations require minors (persons under the age of 18) not receive a dose in excess of 10% of the limits specified for an adult. Minors under the age of 16 are not allowed to work with RAM or RGD. For all practical purposes, it is difficult to guarantee a minor (16 – 18 years old) working with RAM or RGDs will not exceed these limits. Therefore, RSO and RSC approval is required for minors (16 – 18 years old) to be allowed to work with or in areas RAM or RGD are used.

Individual dosimetry exposure history records at UConn Health can be accessed online. Go to the radiation dosimetry vendor's website at <http://www.landauer.com>. In the upper right hand corner of the web page, select "my LDR". Enter UConn Health as both user name and password. The system will prompt you for the account and serial numbers located on the back of your dosimetry badge. Additional instructions can be found on the ORS website.

Labeling and Signage

Areas where RAM are used/stored are labeled in accordance with NRC requirements. Areas where RGDs are used are labeled in accordance to the State of CT requirements.



Radiation Generating Devices

The term radiation generating device (RGD) applies to x-ray, Computed Tomography (CT), Positron Emission Tomography (PET), fluoroscopy, megavoltage linacs, mini C arms, and dental x-ray equipment used at UConn Health.

ORS maintains an inventory of RGDs for UConn Health. All equipment is required to be registered with the State of Connecticut. Contact ORS for assistance with regards to registering equipment.

Please notify ORS prior to the purchase, installation, relocation, or decommissioning of RGDs.

Please submit an x-ray disposition form prior to removal of any RGD from UConn Health.

Only those individuals who have been authorized/certified by the State of Connecticut may operate RGDs on human beings.

Departments utilizing RGDs are responsible for ensuring their devices are maintained and tested in accordance with all applicable regulatory and accreditation requirements, maintaining records of those tests and maintenance activities, and forwarding copies of medical physicist test records to the ORS.

In general, RGDs must be tested by a qualified medical physicist prior to initial use, once every 12 months \pm 30 days, or whenever a medical physicist or individual performing maintenance indicates it is required.

Personal Protective Equipment

Personal protective equipment (PPE) shall be utilized whenever it is required or recommended by ORS. Examples include lead/lead equivalent aprons, thyroid collars, and leaded eye ware.

Departments are responsible for providing PPE to employees and ensuring it is properly worn and maintained to ensure exposures are maintained ALARA.

ORS maintains the official inventory of vests, aprons, thyroid collars and patient protective lead items. Please notify ORS whenever purchasing or disposing of lead/lead equivalent PPE to ensure the inventory is maintained up to date. Upon adding a new item to inventory, ORS will visually inspect and affix a tag indicating the date the item was inspected.

Radiation workers should inspect their PPE prior to each use. If damaged or the tag is missing or the item is overdue for its annual inspection, please contact ORS at x2250.

ORS visually inspects PPE on an annual basis. Items not passing visual/tactile inspection are removed from service. ORS also performs periodic fluoroscopic scans on PPE in high exposure areas such as Cath/EP lab and Interventional Radiology. Items failing their fluoroscopy scan are removed from service.

Additional details regarding use, storage, and maintenance of lead/lead equivalent PPE are provided in ORS SOP-3, "Lead/Lead Equivalent Personal Protective Equipment and Apparel".

Shielding

Areas utilizing RAM or RGDs may require shielding to ensure patients, staff, visitors, and the public are not exposed to harmful levels of radiation.

Contact ORS whenever installing a new RGD, altering the layout of an existing imaging room, or changing the function of an adjacent space.

ORS can design the shielding, review designs provided by others, provide quality assurance during construction, and/or conduct a barrier evaluation after shielding has been installed.

To request a shielding design or barrier evaluation, refer to ORS GL-6, "Shielding Designs and Evaluations for Diagnostic X-Ray Facilities" located on the ORS website or contact ORS at x2250.

Radioactive Materials

Only those materials for which UConn Health is licensed may be used at UConn Health and only after receiving approval from the RSC. Refer to the ORS website for a copy of UConn Health's broad scope license.

Only AUs, PIs, AMPs, the RSO or trained workers working under the supervision of the above may work with RAM.

Work areas (labs) must be reviewed and approved by the RSO prior to use or storage of RAM.

Each PI seeking RAM authorization from the RSC for their lab is provided a radiation safety notebook. These notebooks contain guidelines, procedures, and forms designed to assist the PI in maintaining regulatory compliance.

Failure to maintain notebooks up to date may result in disciplinary action including withdrawal of approval to use RAM. Notebooks must be made available for inspection upon request of the RSO or designee.

Procurement, Receipt, Transfer, Transport, and Disposal of RAM

Contact ORS prior to purchase, transfer, transport, or disposal of RAM for research or investigational use.

The designated location for receipt of RAM is the West Loading Dock.

Once material has been received, it will be placed in a lockable storage container to ensure proper chain of custody. ORS will then survey the shipment to verify it can be transferred to its final destination.

Special precautions shall be taken to avoid accidental spills or release of radioactive material whenever transporting RAM between buildings on the UConn Health campus. Materials should be shielded and packaged so as to prevent spills or releases if accidentally dropped. Transporting material within a building does not require special packaging however, containers (tubes, flasks, etc.) containing radioactive solutions must be capped and transported in a suitable outer container to prevent or contain spills if dropped.

For vehicular transport within the UConn Health campus or to an off campus facility, RAM must be packaged according to Department of Transportation regulations. Contact ORS if you need to ship radioactive material. ORS must receive from the intended recipient facility, a copy of their NRC or state RAM license showing that they are authorized to receive the RAM, prior to shipment.

Refer to Appendix 3, "Handling of RAM Packages" for additional details for opening and inspecting radionuclide shipments.

RAM Work Practices

Keep work areas clean and organized to minimize accidents, contamination, and exposure.

Whenever there is a possibility of RAM becoming airborne, work should be done in a fume hood or glove box. Iodination procedures must be done in a fume hood approved by ORS.

Secure laboratory and storage areas to prevent tampering, loss, theft, or unauthorized removal of radioactive and contaminated material. Labs must be closed and locked whenever they are unoccupied.

Always wear prescribed dosimetry (chest badge, collar badge, ring badge, etc.) when working with RAM.

Do not eat, drink, or apply cosmetics in areas where RAM are used or stored.

Do not store food or beverages in refrigerators or freezers used to store RAM.

Always use appropriate protective measures. Wear lab coats or other protective clothing whenever working with RAM or while in areas where RAM is used. Wear shoes with closed tops. Sandals and similar footwear with exposed tops are not permitted.

Wear disposable gloves whenever handling RAM. Change gloves often to prevent spread of contamination.

Use protective barriers or shielding whenever possible. Lead barriers and lead-glass windows are appropriate for gamma emitters. Plexiglas shields are preferred for high-energy beta emitters such as P-32 or Sr-90.

Use remote handling devices such as forceps or tongs for high activity gamma or beta emitting materials. Syringe shields must be used for preparation and administration of millicurie quantities of gamma emitters.

Use pipette filling devices. Never pipette radioactive solutions by mouth.

Whenever possible, use spill trays for operations involving RAM. Do not use cafeteria trays.

Cover bench top work areas with easily decontaminated or removable materials such as absorbent pads with waterproof backing.

Keep "high activity" vials and syringes in shielded containers.

Store radioactive solutions in covered containers clearly labeled with the name of the radionuclide, chemical compound, date, activity, and radiation exposure rate, if applicable.

Label and isolate RAM, waste, glassware, and contaminated equipment. Glassware and equipment should not be released for other use or removed for cleaning, repair, or as surplus property, until it has been surveyed and demonstrated to be free of contamination.

Always transport RAM in accordance with established procedures.

Immediately report skin contamination, inhalation, ingestion, or injury from RAM or other source of radiation to the PI/AU and ORS.

Survey immediate and adjacent work areas at least once/day whenever RAM are being used. Maintain records of all surveys, including negative results, in the lab notebook.

Survey hands, body, and protective clothing prior to leaving the work area. Perform decontamination as necessary to prevent spread of contamination.

Comply with ORS requests to evaluate internal exposures through bioassay samples and procedures.

RAM Area Surveys

Each laboratory will have on hand or have ready access to a survey meter capable of detecting low levels of radiation. The instrument shall be used to evaluate the levels of radiation in the environment and to monitor personnel and work areas for contamination. Survey meters must be calibrated annually and/or in accordance with OEM recommendations.

Immediate areas (hoods, bench tops, floors) where RAM is used must be checked for contamination at the frequency indicated in the PI's radioactive license, or as otherwise directed by the RSO. Surveys generally consist of an evaluation with swipe media for removable contamination and may include a Geiger Mueller (GM) or sodium iodide (NaI) detector survey for evaluation of fixed contamination.

PIs are required to document survey results in their notebooks.

In addition to the PI surveys, ORS will conduct quarterly surveys of all laboratories containing RAM in accordance with Appendix 4, "RAM Area Surveys".

Contamination Limits

ORS establishes contamination limits to prevent the spread of contamination and to ensure exposures are maintained ALARA.

Users survey their own areas to determine the presence of contamination. In restricted areas, levels of removable contamination should not exceed 2,000 net dpm per 100 cm² for beta and gamma emitters and 100 net dpm per 100 cm² for alpha emitters. Fixed contamination should not exceed 0.5 mR/hr. at 1 cm from the surface.

Unrestricted areas should not have removable contamination levels in excess of one-tenth of the limits stated for restricted areas. Fixed contamination should not result in an exposure rate in excess of 0.2 mR/hr at 1 cm from the surface.

For net readings greater than 100 disintegrations/minute (dpm), users should take steps to decontaminate. For net readings above 2,000 dpm, contact ORS at x2250.

Additional details regarding contamination limits are provided in Appendix 4, "RAM Area Surveys".

Repair and Maintenance of Contaminated Equipment

Contaminated equipment shall not be discarded or processed as surplus until it has been certified to be free of contamination by the ORS. A label will be placed on the equipment with the date of certification. Notify ORS prior to moving, repairing, or disposing of any contaminated or potentially contaminated equipment.

Decontamination of Personnel

If an individual becomes contaminated with RAM, begin decontamination procedures and call ORS at x2250 as soon as possible. Refer to Appendix 5, "Decontamination Methods" for additional details on decontamination of personnel.

To report contamination incidents to ORS occurring outside of normal office hours, call the UConn Health Operator at "0" or Police Dispatch at (860) 679-2121 to obtain the appropriate radiation safety staff emergency numbers.

Security

RAM users are responsible for material control. This includes securing materials to prevent tampering, loss, unauthorized removal, or theft.

Unless materials are stored in locked containers or cabinets, laboratories containing RAM must be closed and locked whenever they are unoccupied.

Some sources may require additional controls as determined by ORS.

ORS performs periodic security inspections to ensure RAM is being properly secured. Failure to properly secure RAM is subject to disciplinary actions up to and including removal of authorization to utilize RAM.

Radioactive Gases, Powders and Aerosols

Procedures involving aerosols, powders, or gaseous products which might produce airborne radioactive material contamination must be approved by the RSO and RSC ahead of time.

Once approved, they must be conducted in an EHS approved hood, glove box, or suitably closed system designed for the specific radionuclide(s) used.

Releases to the environment from hoods or other release points must not exceed the maximum effluent concentrations in air as specified in 10 CFR 20, Appendix B.

Ensure traps and filters are incorporated, as necessary, into the experimental set up to ensure environmental releases are maintained as low as possible.

Air sampling is usually required. The office of Radiation Safety will follow the National Emission Standards for Hazardous Air Pollutants (NESHAP) to evaluate potential radiation releases from the licensed operations for individual members of the public to evaluate that they have not exceeded regulatory limits.

Sealed Radioactive Sources

Sealed radiation sources must be handled with tongs or other remote handling devices to minimize exposure to the hands and body. This procedure is not required but is also recommended whenever handling low activity check sources.

Sealed sources shall be tested for leakage in accordance with license conditions, at least once every six months. Sources emitting alpha particles shall be tested at least once every three months.

Radioactive Waste Disposal

In many cases, radioactive waste may be disposed of as regular trash after it has decayed to acceptable levels.

Refer to Appendix 6, “Radioactive Waste Disposal” for additional details regarding disposal of radioactive waste.

Emergency Procedures

Immediately contact the ORS regarding any accidents, spills, injuries, or emergencies involving RAM or RGDs.

During normal working hours, contact ORS at (860) 679-2250 (x2250)

During off-normal hours, contact Police Dispatch at (860) 679-2121 (x2121)

Refer to Appendix 7, “Emergency Response Procedures” for additional details and contact info.

Use of RAM in Animals

Any PI planning to use RAM in animals must submit an Animal Care Information Form to the ORS for approval. Refer to Appendix 8, “Use of RAM in Animals” for additional details. A copy of the license application form is available on the ORS website.

Medical Event

Medical events involving RAM occur whenever the dose administered differs from the amount prescribed and the difference meets NRC reporting requirements outlined in 10 CFR 35.3045 and one or more of the following incidents occur:

- The dose given is off by at least 20 percent from the prescribed dose, either too high or too low, or outside the prescribed dose range,
- The wrong drug is used,
- The drug is given by the wrong route,
- The drug is administered to the wrong individual,
- A dose is administered to the wrong part of the body and exceeds by 50 percent or more the dose that area should have received, or
- A sealed source used in the treatment leaks.

Report all medical events to ORS as soon as possible.

Sentinel Event

A sentinel event is defined by The Joint Commission as a patient safety event that results in any of the following:

- Death
- Permanent harm
- Severe temporary harm and intervention required to sustain life

Radiation Overdose Sentinel Event

A radiation overdose sentinel event is defined as a fluoroscopic procedure resulting in a peak skin dose greater than 15,000 mGy (15 Gy) within a 6 to 12-month period.

Radiation sentinel events require immediate investigation and a report to the Joint Commission within 45 days of discovery of the event.

Audits

ORS conducts periodic audits of individuals, departments, and facilities to ensure compliance with the requirements of the program. Results are reported to the RSC on a quarterly basis.

Annual Review

The RSO, in conjunction with the RSC, performs an annual review of the Program and reports results to executive management.

The annual review shall include but not be limited to, review of material and equipment inventories, dosimetry records, training records, survey records, medical or sentinel events,

metrics reported to the RSC, and results of audits or inspections performed by ORS, contractor personnel, or regulatory agencies.

The principal purpose of this review is to verify compliance with license and regulatory requirements and to ensure exposures are being maintained ALARA.

Appendix 1, “NRC Form 3”

NRC Form 3 “Notice to Employees” outlines various employer and worker rights and responsibilities with regards to radiation safety.

To comply with 10 CFR 19.11, the Office of Radiation Safety posts copies of Form 3 in conspicuous locations where licensed activities occur to ensure individuals engaged in those activities have an opportunity to observe the form.

It is also provided here via the following link:

<https://www.nrc.gov/reading-rm/doc-collections/forms/nrc3info.html>

Appendix 2, “RSO Roles & Responsibilities”

The RSO is responsible for development, implementation, and oversight of the radiation safety program. This includes the radiation safety manual and all processes, guidelines, and procedures developed in support of the manual.

The RSO acts as a technical resource on matters related to radiation safety, maintaining exposures as low as reasonably achievable (ALARA), and compliance with NRC and State of Connecticut regulations related to the use of radioactive materials and radiation generating devices.

The RSO is responsible for ensuring UConn Health is compliant with the terms and conditions of its broad scope license.

The RSO is the primary point of contact for the Connecticut Department of Energy and Environmental Protection (DEEP), United States Nuclear Regulatory Commission (NRC), The Joint Commission (TJC), Department of Public Health (DPH), and any other regulatory agency overseeing the licensing, registration, use, inspection, or disposal of radioactive materials and radiation generating devices.

The RSO is authorized to stop work if he/she feels it violates the requirements of the NRC license, radiation safety program, places patients, staff, or visitors at risk, or does not ensure exposures are being maintained ALARA.

Other responsibilities include:

- Develops and implements policies and procedures related to radiation safety
- Defines the radioactive material procurement process. Ensures adequate approvals exist prior to purchase of radioactive material and radiation generating devices
- Reviews/approves proposed changes to the broad scope license
- Reviews/approves proposed activities involving use of ionizing radiation
- Provides technical support and expertise on matters related to radiation safety
- Member of Radiation Safety Committee
- Oversees performance of audits to ensure compliance with the program
- Maintains awareness of proposed regulatory changes
- Ensures exposures are ALARA and within regulatory guidelines
- Participates in the design, construction, and renovation of areas containing or supporting the use of radioactive materials and radiation generating devices
- Reviews investigations of overexposures, accidents, spills, losses, theft, unauthorized receipt, misuses, transfers, disposals, and other deviations from approved radiation safety practices. Implements corrective actions when necessary

- Reports radiation safety concerns to the Radiation Safety Committee and/or CEO of UConn Health
- Responds to radiation safety emergencies. Prepares and submits reports to the NRC, DEEP, DPH, etc., as required by law
- Provides technical support and expertise to radiation decontamination efforts
- Coordinates and/or performs an annual audit of the Radiation Safety Program
- Audits data pertaining to individual and area dosimeters on a quarterly basis
- Oversees work of technical staff. Acts as an educational resource and directs staff to ensure regulatory compliance

Appendix 3, "Handling of RAM Packages"

Federal law requires incoming radionuclide shipments be examined for leakage, contamination, or damage and that procedures be established for safely opening packages.

The Office of Radiation Safety will perform these tasks on packages delivered to UConn Health prior to transporting the package to the investigator. Under certain conditions, such as a shipment in dry ice, ORS will monitor the exterior of the package and deliver it unopened. The investigator would then be responsible for opening the package and examining the contents. ORS can also do this if requested.

The following procedures apply to opening and inspecting packages:

1. Wear disposable plastic gloves while processing the package and its contents. All processing of packages and their contents must be performed on absorbent liners to prevent spread of contamination.
2. Inspect the package immediately upon receipt. Radioactive solutions inadvertently stored upside down may gradually leak and cause contamination problems.
3. Measure the exposure rate at one meter from the surface of the package. Contact ORS if > 10 mR/hr.
4. Measure the exposure rate at the surface of the package. Contact ORS if > 200 mR/hr.
5. Wipe test the outside of the package for removable contamination.
6. Open the package and verify contents agree with the packing slip (name/Qty.).
7. Check for possible breakage of seals or containers, loss of liquid, or change in color of absorbing material.
8. Wipe test the vial (bottle) containing the radioactive material. If contamination, leakage or shortages are observed, notify ORS immediately.
9. Monitor the packing material and packages for contamination before discarding. If not contaminated, deface radiation labels and discard as normal trash, or follow established procedures to return Styrofoam box to the manufacturer for recycling.
10. Maintain a record of package receipts in your Radiation Safety notebook. Records should identify the shipment date, radioactive material, quantity, the radiation levels at the package surface and at one meter, and the results of the wipe tests.
11. Notify the ORS if a swipe survey result is $> 2,000$ net dpm.

Appendix 4, "RAM Area Surveys"

Radiation surveys must be performed on at least a monthly basis in each laboratory where radioactive materials are used and/or stored. Surveys should be performed more frequently if radioactive materials are used on a daily basis.

Basic Survey Procedure:

- 1) Draw a map of your lab. Label all equipment, work surfaces, and floor areas with a reference number. Include items such as handles and door knobs in your survey.
- 2) Use a GM survey meter to measure external radiation levels at waist or chest level and at one foot from areas where radioactive materials are stored. Shield or reposition items to maintain exposure rates in occupied areas < 2 mR/hr.
- 3) Perform wipe tests of all referenced areas/items on the map using either small pieces of filter paper or cotton swabs. Place the samples in correspondingly numbered counting vials.
- 4) Count the samples using a liquid scintillation counter (for beta and gamma emitting radionuclides) or gamma counter (for gamma only radionuclides).
- 5) Samples with results > 100 net dpm indicate areas needing to be decontaminated. Recount positive samples to check for chemiluminescence before performing decontamination. Refer to the following formulas as needed:
 - a) Net dpm = [swipe cpm - background cpm]/counter efficiency (cpm/dpm)
 - b) Surveyed items can be declared non-radioactive if they are not significantly different from background radiation, i.e., sample count < critical count.
 - c) Critical count = $2.32 * \sqrt{\text{Bkg}} + \text{Bkg}$. Bkg = background sample count.

Appendix 5, “Decontamination Methods”

Basic decontamination methods are provided in this appendix. Always contact the Office of Radiation Safety at x2250 for assistance with personnel decontamination.

Personnel Decontamination Methods

Affected Area	Method*	Action	Technique	Advantages	Disadvantages
Skin and hands	Soap and water	Emulsifies and dissolves contaminant	Wash 2-3 minutes and monitor. Do not wash more than 3-4 times.	Readily available and effective for most radioactive contamination	Continued washing will defat the skin. Indiscriminate washing of other than affected area may spread contamination.
Skin and hands	Lava soap, soft brush and water	Same as above	Use light pressure with heavy lather. Wash for 2 minutes, 3 times. Rinse and monitor. Use care not to scratch or erode the skin. Apply lanolin or hand cream to prevent chapping.	Same as above	Continued washing may abrade skin.
Skin and hands	Detergent	Same as above	Make into a paste. Use additional water with a mild scrubbing action. Use care not to erode the skin.	Slightly more effective than soap and water	Will defat and abrade skin. Use with care.
Hair	Soap and water	Same as above	Wash several times. If contamination is not lowered to acceptable levels, shave head and treat as skin.	Same as above	Same as above

*Begin with first method then proceed, with ORS assistance, to more severe methods.

Area and material decontamination methods

Method*	Surface	Action	Technique	Advantages	Disadvantages
Water	Non-porous surfaces	Dissolves and erodes	Contact ORS immediately. Cover with absorbent plastic backed diapers/towels working from spill perimeter inward. Apply only enough water to wet area and wipe with absorbent towels. Begin at perimeter working toward larger amounts of contamination. Wear appropriate PPE.	Contains and prevents spread of contamination	Possibility of spread of contamination. Allows dried contamination to become mobile.
Water	All surfaces	Same as above	For small surfaces, blot up liquid with paper towels and hand wipe with water and appropriate commercial detergent. Apply same principals as for large surfaces.	Effective if done immediately after spill.	Not effective on large spills, longstanding contaminants, or porous surfaces.
Detergents	Non-porous surfaces	Emulsifies contaminant and increases wetting power of water	Similar to water		
Abrasion	Non-porous surfaces	Removes surface and/or contaminant	Use SOS or Brillo pad moistened but not saturated. Rub contaminated area. Wipe dry and survey. Wet sanding is also an option.	Contamination may be reduced to a desired level.	Impractical for porous surfaces. Large areas difficult to decontaminate

*Begin with first method then proceed, with ORS assistance, to more severe methods.

Appendix 6, “Radioactive Waste Disposal”

The Nuclear Regulatory Commission (NRC) requires that all licensees maintain written records regarding receipt, storage and disposal of radioactive material. This information must be recorded by Principal Investigators and supplied to the Office of Radiation Safety. ORS compiles appropriate records from this information and prepares it for review during NRC and state inspections.

Radioactive waste requires the same security considerations given to other radioactive materials. The Principal Investigator is responsible for safe and proper storage of radioactive waste in his/her lab until it is removed by ORS.

In general, radioactive waste must be placed into an appropriate and properly labeled container prior to being picked up, processed and/or disposed of through the Office of Radiation Safety. The basic elements of the Radioactive Waste Management Program at UConn Health are:

- Minimization of radioactive waste
- Segregation of radioactive waste by radionuclide
- Placement of segregated waste into proper containers
- Proper labeling of each waste stream

Investigators are reminded that the volume of radioactive waste generated must be kept to a minimum, and therefore items that are known not to be contaminated with radioactive material should not be placed into a radioactive waste container.

Call Radiation Safety, x-2250 to schedule waste pick-up, delivery of supplies, or for additional waste disposal information. The following supplies are available through the Office of Radiation Safety:

- Five gallon pails
- Half and gallon radionuclide labeled plastic bottles for liquids and Pasteur pipettes
- 5 gallon plastic bags for animal waste
- Waste cards
- Waste tags with ties

Specific instructions for proper disposal of each type of radioactive waste generated are provided here in this document.

Solid Dry Waste

Solid dry radioactive waste must be segregated by radionuclide. It is requested that only one radionuclide per work station be used. Place a radionuclide label on your benchtop radioactive dry waste container.

If permission has been given to generate waste which is contaminated with more than one radionuclide, or waste is accidentally contaminated with more than one radionuclide, then a container for that combination of radionuclides is required. Contact ORS x2250, for more information.

Contaminated waste items may be placed directly into a dry radioactive waste container, usually a 5 gallon pail. Placing items into a plastic bag prior to being placed into a dry waste container is not required.

Record information requested on the "Solid Dry Waste Disposal Record" card located on top of the drum/pail with each disposal into the drum/pail.

A Radiation Safety representative will complete a "Caution Radioactive Materials" tag from information you provide on this card when the container is picked up.

Provide the information requested by Radiation Safety when scheduling a dry radioactive waste pick-up. Such information may include:

- Radionuclide
- Location - Room Number
- Supplies needed
- Investigator's name

Place each contaminated Pasteur pipette into the proper 1 gallon plastic bottle labeled for that one specific radionuclide. When full, secure cap on bottle prior to disposal into the appropriate container. Make an entry on the "Solid Dry Waste Disposal Record" card.

Place each contaminated sharp item, (i.e., needle, razor blade, scalpel...) into the proper sharps container labeled for that one specific radionuclide. These containers can be purchased from the Warehouse's Supply Catalog or through an outside vendor. Label each container for one specific radionuclide. When full, close container, as necessary, prior to disposal into the appropriate container. Make an entry on the "Solid Dry Waste Disposal Record" card.

Deactivate infectious agents or possible infectious agents in human blood or body fluids associated with the radionuclide contaminated waste items prior to disposal.

Neutralize any chemical hazards or carcinogenic agents associated with the radionuclide contaminated waste items prior to disposal.

Damp items (paper towels, blue pads) may be disposed of into a Solid Dry Radioactive Waste container. All excess liquid should be drained into a radionuclide labeled liquid waste bottle prior to disposal of an item into a Solid Dry Radionuclide labeled Waste container.

Securely capped stock vial containers may be disposed of into a Solid Dry Radioactive Waste container. Other small containers (test tubes, etc.) containing radioactive liquid must be emptied into a radionuclide labeled bottle as is practicable. Place the uncapped empty tubes into the appropriate Solid Dry Radionuclide labeled Waste container.

Liquid Scintillation Counting Sheet waste may be disposed of into a Solid Dry Radioactive Waste container if a biodegradable and/or environmentally safe fluor has been used.

Do not dispose of the following into any Solid Dry Radionuclide labeled Waste container:

- Animals, animal tissue or animal bedding
- Lead (This item is collected separately. Call Radiation Safety for pick0 up.)
- Any toxic, flammable, or otherwise hazardous materials
- LSC vials/plates containing liquids

- Loose sharps. Other large sharp objects such as broken glass must be placed in a protective container (cardboard box) and sealed with tape prior to disposal into the waste pail.
- A container other than a stock vial with radionuclide contaminated liquid which has not been emptied into a liquid waste container.
- REMEMBER ... OTHERS WILL HANDLE YOUR WASTE CONTAINERS!!!

Liquid Scintillation Counting (LSC) Vial/Plate Waste

LSC vials and LSC plates must be placed into a separate LSC Vial or LSC Plate 5 gallon waste pail respectively.

LSC vials or plates that contain H-3, C-14, P-32, P-33, Cr-51, and radionuclides with a half-life < 30 days are all placed into one deregulated LSC vial or plate pail.

LSC vials or plates that contain S-35, I-125, Ca-45, and radionuclides with a half-life > 30 days (other than H-3 and/or C-14) shall be segregated by radionuclide as regulated LSC vial/plate waste. Place one radionuclide into each regulated LSC vial/plate pail. Place non-radioactive LSC fluor filled vials into a deregulated LSC vial pail.

Biodegradable and/or environmentally safe fluors must be used.

Small (4ml or 7ml) LSC vials should be used whenever possible.

Do not place any other waste into an LSC waste pail.

Record information requested on the "Liquid Scintillation Counting (LSC) Vial/Plate Waste Disposal Record" card located on top of the pail with each disposal into the pail.

A Radiation Safety representative will complete the "Caution Radioactive Materials" tag from information provided on the card when the pail is picked up.

Provide the information requested by Radiation Safety when scheduling a LSC waste pick-up. Such information may include:

- LSC vials or LSC plates
- Deregulated or Regulated LSC
- Location - Room Number
- Supplies needed
- Investigator's name

Animal Waste

This type of waste must also be segregated by radionuclide. Animals and animal tissue must be kept frozen until picked up by Radiation Safety.

If animals, animal bedding or containers with tissue samples have more than one radionuclide (permitted only as a result of dual labeling experiments) then identify each radionuclide and their respective estimated activities.

Place animal carcasses into an appropriate thick plastic bag. Bend appendages, as necessary, to reduce volume and prevent claws from puncturing bags.

Place animal bedding into an appropriate thick plastic bag.

Place containers with tissue samples and other similar waste into a thick plastic bag.

Animal carcasses, animal bedding, and containers with tissue samples must be kept segregated by type and radionuclide.

Record all the appropriate information requested on the "Caution Radioactive Materials" tag. Place top copy of tag inside an envelope attached to the outer surface of your freezer. Insert plastic tie through eyelet of the tag and use the tie to seal the bag containing the animal waste. Place sealed bag with tag into a radioactive materials labeled freezer until picked-up by Radiation Safety.

Provide animal waste information to Radiation Safety when scheduling an animal waste pick-up. Such information may include:

- Radionuclide(s)
- Type of waste (animal carcasses, bedding, or tissue samples)
- Number of plastic bags
- Location - Room Number
- Supplies needed
- Investigator's name

Non-Hazardous Liquid Waste

The Office of Radiation Safety provides pre-labeled one gallon plastic jugs for collection of non-hazardous liquid waste. A non-hazardous liquid waste is a radioactive liquid waste which contains no EPA defined hazardous chemicals. Each container is labeled for the radionuclide it may contain.

If you are generating liquid waste that may not be compatible with the plastic containers provided, call the Office of Radiation Safety for alternatives. Store liquid waste containers in areas (plastic bins) that will contain any leaks. The use of radionuclide pre-labeled liquid waste bottles is the primary means of collecting liquid radioactive waste for disposal at UConn Health licensed facilities.

Liquid waste must be segregated by radionuclide and picked up by the Office of Radiation Safety.

If permission has been given to generate waste which has more than one radionuclide (permissible only as a result of dual labeling experiment), a separate liquid waste container for that combination of radionuclides is required. Call the Office of Radiation Safety for more details.

Place only liquid in the bottle. Keep bottle capped when not in use.

Segregate radioactive liquid wastes by their toxicity and radionuclide as indicated below. The generation of chemically hazardous radioactive liquid wastes, known as mixed wastes, must be avoided. See Section E. for more details. In addition to segregating by radionuclide, segregate liquid waste as follows:

- Water soluble and chemically non-hazardous are placed into radionuclide labeled plastic bottles provided by Radiation Safety. This includes liquids containing < about 20% ethanol or < 10% methanol.

- Chemically hazardous as determined by the Environmental Protection Agency (EPA). Such wastes are usually placed into a 1 gallon glass bottle provided by the Investigator.

Pour liquid waste through a funnel into the appropriate radionuclide pre-labeled 1 gallon plastic bottle provided by Radiation Safety. Care should be taken to avoid splattering and spillage around the outside of the bottle. Do not fill to capacity!! Allow a couple of inches of space below the cap. Cap bottle after dispensing. The funnel should be placed into a radioactive material labeled beaker or other appropriate container when not in use.

Determine the pH of the liquid waste by using Litmus Paper. The liquid waste should be tested for pH when the bottle is ready for pick-up. The acceptable pH range is 6-10. Waste neutralization is considered to be an integral and final step of your experimental protocol. If it appears the volume to neutralize the waste solution will exceed the capacity of the bottle, pour some of the waste solution into another waste bottle and continue to neutralize the solutions in both bottles. Face shield, protective gloves, and lab coat should be worn while slowly adding a neutralization agent to the waste solution and should be done under a chemical fume hood. Sodium Bicarbonate (mild agent) or Sodium Hydroxide pellets (strong agent) can be used to neutralize an acidic solution. Acetic Acid (mild agent) can be used to neutralize a basic solution. Heavy metal acids or bases are not acceptable as neutralization agents. Call the Environmental Health and Safety Office at x2723 for any questions regarding safety prior to performing such neutralization procedures.

Deactivate infectious agents or possible infectious agents in human blood or body fluids associated with the radionuclide contaminated liquid waste. This can usually be done with a 10% bleach solution. Contact the Environmental Health and Safety Office (x2723) for proper procedures.

Record information requested on the "Caution Radioactive Materials" tag. Insert plastic tie through eyelet of the tag and affix the tag to the handle of the bottle.

Provide the information requested by Radiation Safety when scheduling a non-hazardous liquid waste pick-up. Such information typically includes:

- Radionuclide(s)
- Volume
- pH
- Solvent(s) and solute(s)
- % contribution by volume of ethanol or methanol
- Location - Room Number
- Investigator's name

Hazardous Liquid Waste and Mixed Waste

Any liquid waste containing radioactive material and an EPA identified hazardous chemical waste is known as a mixed waste. This includes "aqueous" solutions with trace amounts of these chemicals.

UConn Health encourages the minimization of this waste stream. Depending on the mix of chemical and radionuclide, such waste may have no acceptable method of disposal. Questions

regarding mixed and/or chemically hazardous waste should be directed to the Office of Radiation Safety (x2250) and/or the Environmental Health and Safety Office (x2723).

Follow the procedures provided in Section D., except where they differ with the additional instructions provided below. Additional instructions for mixed waste collection and disposal include:

- Each container must be labeled with a "hazardous waste" label. A minimum 1 gallon size glass bottle is required, unless other alternatives are otherwise allowed by the Office of Radiation Safety.
- The label must have printed on it the name of the hazardous constituent, such as "PHENOL". Chemical symbols shall not be used. This label must be attached to the bottle when you begin to fill the bottle.
- Container must be capped at all times when not in active use.
- Sewer disposal is prohibited.
- The % concentration of the hazardous constituent must be indicated on the "hazardous waste" label. This information can be obtained by "process knowledge".

Provide the information requested by Radiation Safety when scheduling a mixed liquid waste pick-up. Such information may include:

- Radionuclide
- Volume
- pH
- Solvent(s) and solute(s)
- % contribution by volume of each solvent
- Location - Room Number.
- Investigator's name

Sewer Disposal of Non-Hazardous Liquid Wastes

UConn Health strongly recommends that all radioactive liquid waste be placed into approved bottles for pick up by the Office of Radiation Safety. Laboratory personnel may dispose of limited quantities of radioactive material such as rinse water from the decontamination of lab ware or washing of radionuclide incorporated filters, provided the following conditions are met:

- The liquid must be in a chemical form that is soluble in water and is not hazardous by EPA standards. If you have any questions, call the Office of Radiation Safety, (x2250).
- The liquid must have a pH between 6 and 10.
- The perimeter of a designated radionuclide sewage disposal sink(s) must be delineated with appropriate "Caution Radioactive Material." tape.
- Post a "Radionuclide Sewer Disposal" form, available from Radiation Safety, in a visible and readily accessible area near the sink.
- Record information requested on the form with each sewer disposal.
- Report this sewer disposal information to the Office of Radiation Safety on the 6-month radionuclide inventory form.

If you anticipate generating large volumes of liquid radioactive waste please contact the Office of Radiation Safety for guidelines concerning sewer disposal options.

In Vitro Waste

The Office of Radiation Safety will evaluate on a case-by-case basis, special requests to use an in-vitro waste container. In vitro waste is defined as a vial, test tube, or other similar receptacle with more than residual liquid present. As a general rule, items containing liquid are usually decanted into a radionuclide specific liquid waste container.

Appendix 7, “Emergency Response Procedures”

Minor Spills

Notify personnel in the area that a spill has occurred.

Cover the spill with absorbent paper or other absorbent material. Do not let personnel walk through the area.

Use disposable gloves and remote handling tongs if appropriate. Carefully clean up the spill and the absorbent material or pad. Place all materials (absorbent pads, gloves, towels, etc.) into a plastic bag. Place the bag into a radioactive waste container.

Using a low range, thin-end GM survey meter, check the area around the spill and the hands, shoes, and clothing for contamination. If the spill consists of a low energy beta emitter such as ³H, perform wipe tests and analyze them in a liquid scintillation counter to determine degree on contamination and need for additional cleaning.

Record incident, measures taken, and outcome of surveys in the radiation safety notebook.

Report incident to the Office of Radiation Safety at x2250.

Major Spills

Notify all persons not involved to evacuate the room.

Cover the spill with absorbent pads but do not attempt to clean it up. Confine the movement of all personnel potentially contaminated to prevent spread of contamination.

If possible, the spill should be shielded but only if it can be done without further contamination or without significantly increasing your own radiation exposure.

Leave the room and lock the door(s) to prevent entry.

Contact ORS at x2250 or use the emergency notification procedure for off hours.

Fire/Explosion Involving RAM

Leave the room and lock the door(s) to prevent entry.

Notify all personnel in the area at once. Remove any individuals who are severely injured as appropriate and necessary to a safe area. Life-saving activities are a top priority.

Dial 7777 to report the emergency. State the problem; give the location and a telephone number.

If a radiation hazard is not immediately present, attempt to extinguish the fire with the appropriate type of fire extinguisher.

Fire or explosion may result in airborne radioactivity. Stay upwind and avoid smoke, fumes, and dust. Hold breath if practical.

Restrict access to the incident area and prevent unnecessary handling of incident debris. Do not permit anyone to leave except for medical treatment. Get names and addresses of persons removed.

Segregate clothing and tools used at the fire. The Radiation Safety Office will survey these items for radioactive contamination.

Take appropriate action for injuries, spills, or contaminated personnel.

Injured Contaminated Individual

Make every effort possible to rescue injured persons and remove them as appropriate and necessary from the incident area.

If appropriate, initiate UConn Health's emergency response system by dialing 7777 on the telephone. State the nature of the problem, the location and telephone number.

Unless administered by a Physician, Nurse, Emergency Medical Technician or appropriate medical staff, first aid should be limited to those situations where it is necessary to save life or minimize injury.

Wash minor wounds immediately under running water while spreading the edges of the wound.

Remove and save all articles of contaminated apparel. (i.e., lab coat, shoes, jewelry).

Injured and potentially contaminated persons not requiring immediate medical attention should not be permitted to return to work or leave the premises without the approval of a physician and clearance from Radiation Safety personnel.

If it is necessary to send an individual to the Emergency Department before a Physician or Radiation Safety personnel have arrived, inform emergency personnel that the injured person may be contaminated with radioactive material. Notify the Emergency Department (x2588) of the pending arrival of the possibly contaminated patient.

Appendix 8, "Use of RAM in Animals"

Principal Investigators planning to use radioactive materials on animals must complete and forward an animal care information form to ORS for approval.

Rooms housing RAM animal cages shall be protected against unauthorized entry and posted with a "Caution, Radioactive Material" label or sign on the door.

Cages housing animals shall be posted with a "Caution, Radioactive Material" label or sign. The label/sign must indicate the radionuclide, date of administration, activity administered, and the name and phone number of the Principal Investigator and/or Individual Users.

Animal caretaker procedures shall be provided to ORS for review and approval. Procedures shall be posted on or near the animal cages and shall contain steps taken in the event of animal illness or death. Animal carcasses shall be treated as radioactive waste.

Principal Investigators and staff are responsible for surveying cages, animal rooms and other related items for contamination and documenting the results. Contaminated items/areas are to be decontaminated prior to their release from radiation precautions.

Als and UIs shall ensure proper containment of radioactive animal waste using plastic backed absorbent paper or other appropriate excreta collection systems.

Als and UIs are responsible for proper disposal of animal related radioactive waste.

ORS shall determine if personnel radiation monitoring badges are needed by animal care personnel and any other precautions that should be taken to maintain exposures ALARA.