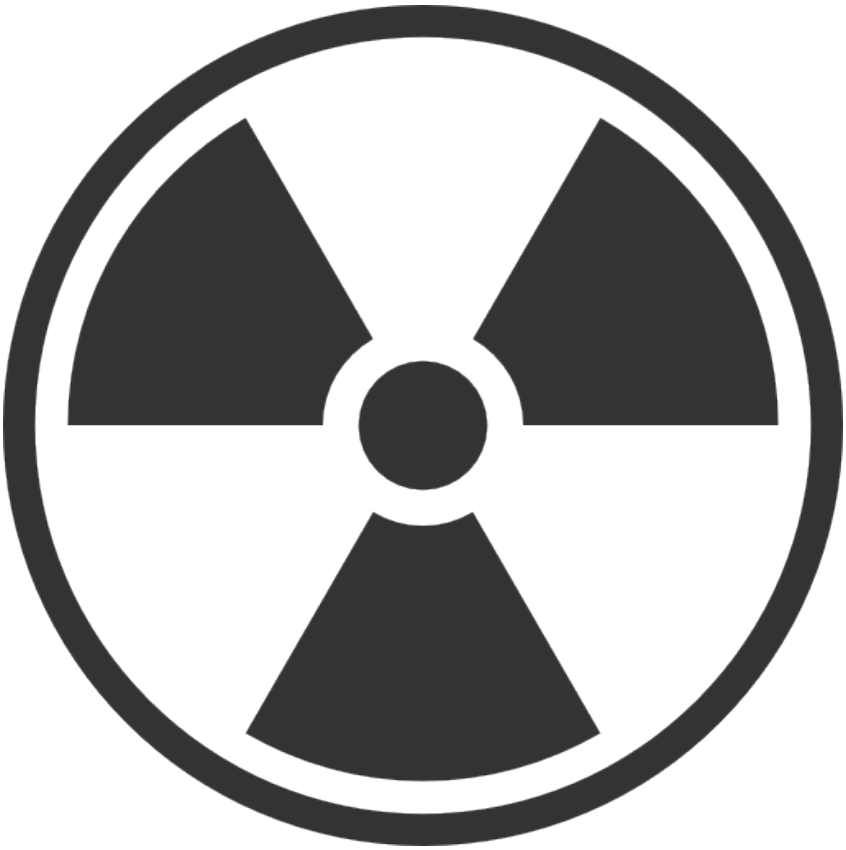
# Radiation Safety Handbook/Policy for UNSEALED SOURCES



Radiation Safety Program | 405-744-7890 | https://research.okstate.edu/research-compliance/rso/

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# Overview

Personnel on the Oklahoma State University (OSU) -Stillwater and OSU-Tulsa campuses who use unsealed sources of radioactive materials (RAM) must adhere to applicable federal and state regulations and institutional policies. Refer to OSU's Institutional Radiation Safety Policy and the Radiation Safety website for specific regulatory links and additional guidance.

This handbook is designed to outline the responsibilities of RAM Principal Investigators (PIs) who use unsealed sources and assist them in designing their projects and research activities, while maintaining compliance with safety regulations and best practices.

The Nuclear Regulatory Commission (NRC) defines a sealed source of RAM as "radioactive material that is sealed in a capsule or closely bonded…" By default, any RAM source that does *not* meet this definition is an "unsealed source."

For the purposes of this document, "unsealed source" and "RAM" will be used to refer to any source of RAM that 1) may leak, spill, or contaminate objects and people *under normal use conditions,* and 2) is regulated by OSU's Broad Scope license (except for Section 2).

Radiation Safety personnel will periodically update this handbook and linked documents. *We strongly recommend that you bookmark this handbook in your browser as opposed to printing it.*

# Section 1: Radiation Safety Program Oversight

RAM use, from ordering, procurement, transportation, storage, method of use, waste, to final disposal, is regulated. There are federal and state regulations that must be followed, as well as institutional polices that are in place to ensure that federal and state regulations are met.

## 1.a: Institutional Oversight

OSU's Radiation Safety Office works to ensure that all aspects of research and instructional activities that involve the use of unsealed sources of RAM, occurring on the OSU-Stillwater & OSU-Tulsa campus are compliant with all applicable regulations and institutional policies. The Radiation Safety Office is in the Office of University Research Compliance (URC). URC is under the purview of the Vice President for Research (VPR).

The Radiation Safety Office is managed by the Radiation Safety Officer (RSO), who is tasked with ensuring the safety of OSU faculty, staff, and students, as well as members of the general public, while enabling the use of unsealed sources in a variety of research and instructional activities on the referenced OSU campuses.

**Radiation Safety Office Personnel Contact Information** can be found on OSU's Radiation Safety website.

## 1.b: State and Federal Oversight

Because Oklahoma is an agreement state[1], the RAM licenses held by OSU are issued by the Oklahoma Department of Environmental Quality (ODEQ). The ODEQ

may incorporate, by reference, the federal Nuclear Regulatory Commission (NRC) regulations into Oklahoma Radiation Management Rules.

The majority of unsealed sources on the OSU-Stillwater campus fall under OSU's type A broad scope license, as issued by ODEQ. While this license covers the majority of unsealed sources of RAM at OSU, there are some sources that fall under the general license (see Section 2).

In addition to the ODEQ, which regulates acquisition, use, and disposal of RAM, the Oklahoma Department of Transportation (ODOT) regulates the transportation of RAM on state roadways. ODOT follows the U.S. Department of Transportation's (USDOT) regulations.

ODEQ Regulations: Oklahoma Administrative Code (OAC) 252:410
NRC Regulations: Code of Federal Regulations (CFR); 10 CFR Parts 19, 20, and 30-33
USDOT Regulations: Code of Federal Regulations (CFR); 49 CFR Parts 100-177

[1] An agreement state is defined by OAC as "any state with which the U.S. Nuclear Regulatory Commission or the U.S. Atomic Energy Commission has entered into an effective agreement under subsection 274(b) of the Atomic Energy Act of 1954, as amended (73 Stat. 689; 42 USC §2021 *et seq.*)"

# Section 2: Generally Licensed Material

There are certain types and quantities of radioactive materials that people and institutions may work with that will not require the purchaser to hold a specific license to possess and use. The NRC and, by extension, ODEQ allow these materials to be possessed and used under a "general license." However, these general license qualifications do have limits, and because OSU holds a Type A Broad Scope license, the line between a general license and our Broad Scope license is not always clear. In order to avoid confusion and inadvertent regulatory violations, **the Radiation Safety Office should be contacted prior to ordering *any* radioactive material**. The Radiation Safety Officer should be the one to determine if the RAM you want to purchase will require you to become a RAM PI or if it falls under the purview of a general license. If it is regulated by OSU's Broad Scope license, you will need to follow the guidelines outlined in the rest of this handbook.

While certain state and federal regulations may not apply to some generally licensed material, any waste produced that contains generally licensed radioactive material must still be treated as radioactive waste. Additionally, USDOT and ODOT regulate the transportation of such material. All RAM shipments that will be used in research laboratories will be sent directly to the Radiation Safety Office for package check-in.

For more information, please contact the Radiation Safety Office or visit OSU's Generally Licensed Materials and Devices webpage.

# Section 3: Record Keeping via the URC Assistant Database

The Radiation Safety Office uses a software system, the URC Assistant, to help track PIs, permit limits, users, training requirements and due dates, inventory, waste, approved labs, inspections, and equipment. This database is a very helpful tool used to maintain accurate and current records, but it does require PIs to communicate changes to their inventory and list of trainees in a timely fashion. Quarterly reports (see Section 12.b) are sent to RAM PIs to verify that current records in the Radiation Safety Office are up to date.

Radiation Safety personnel can help guide PIs through the process of entering order requests, logging RAM uses and disposals, and submitting waste requests.

# Section 4: Approval/Standard Operating Procedure (SOP)

The use of unsealed sources of RAM on the referenced OSU campuses requires current authorization for use to be on file in the Radiation Safety Office. To obtain authorization, RAM PIs are required to submit a RAM Use Application to the Radiation Safety Office. Authorizations must be renewed every three years.

Information that is required to be in the application and SOP include, but is not limited to:

- radioisotope(s) and activity;
- how the radioisotope will be used and stored;
- how RAM waste will be handled and disposed of;
- how users will reduce their overall exposure; and
- security measures to prevent unauthorized access to RAM.

The application must be submitted to the Radiation Safety Office, where personnel will ensure that all required information is included before submitting it for review to the Radiation Safety Committee (RSC), which issues final approval. Under certain circumstances, the RSO may grant provisional approval until the RSC meets to review the application.

Upon RSC approval of an application, PIs will receive a copy of the application with all required signatures and a signed letter of approval via campus mail. The letter of approval will include:

1. your approval number, which is to be used on routings for grant proposals and other awards that will involve the use of the RAM;
2. your approval date; and
3. your approval expiration date.

**You should retain copies of both the signed application and the letter of approval with your records. Copies of the letter of approval will also be sent to your department head via campus mail.**

# Section 5: Inventory

The Radiation Safety Office must approve the purchase of all RAM and maintain current inventory of the radioisotopes present on campus. During inspections, inventory reports will be printed using the data in the URC Assistant for comparison to the inventory found in your lab. It is very important for PIs to keep their online inventory up to date, as discrepancies between the expected inventory and the actual inventory could result in a violation being issued by the Radiation Safety Office.

## 5.a: Acquisition

The Radiation Safety Office should ***always*** be consulted before an order for radioactive materials is placed. It is the PI's responsibility to ensure that the Radiation Safety Office has approved the purchase of RAM unsealed sources *prior to placing the order*. The approval must be dated at least one day before the package arrives on campus. The purchase of RAM without RSO authorization is a violation of OSU's Broad Scope license.

Approval is obtained by entering a request into the URC Assistant database[1] (contact Radiation Safety personnel for assistance with this process). Radiation Safety Office personnel will review requests, and an e-mail message will be sent to the PI informing him/her that the request was approved or denied.

Upon receipt of approval, the order may be placed with the vendor. It is possible that the vendor will require verification that OSU has a current material license

and is authorized to possess the radioisotope and activity being purchased. Radiation Safety Office personnel will provide copies of the appropriate license upon request.

All RAM packages shipped to the OSU-Stillwater campus will be labeled, as required by USDOT and ODOT (49 CFR Parts 100-177). University Mailing Services (UMS) personnel will notify the Radiation Safety Office personnel of all packages with RAM shipping labels and will only release these packages to Radiation Safety Office personnel. Radiation Safety personnel will then check in the package and perform the required survey, to confirm that there has been no leakage of RAM during transport.

Any package that arrives on campus without prior RSO approval will be held in the Radiation Safety laboratory until Radiation Safety personnel have confirmed that the purchaser is authorized to possess the RAM, has appropriate training and procedures in place, and corrective action has been taken to prevent a recurrence of unauthorized purchases. If the purchaser is not approved for the radioisotope being ordered, the package will not be released to the purchaser until all institutional and regulatory requirements for authorized use have been met.

[1] You will only be able to request approval to purchase the radioisotopes for which you are already approved. If you do not have current authorization to possess and use the radioisotope you wish to purchase, you will not be able to enter a request. Authorization must be in place before you can obtain approval to purchase.

## 5.b: Storage of Inventory

Storage of radioactive materials must be done in such a way as to meet the following criteria:

- *Unauthorized access to RAM must be prevented.* This means that no untrained, unauthorized person (this includes custodial staff) should be able to enter your lab space and remove or relocate RAM. There are several ways to accomplish this, the easiest of which is to ensure that the refrigerator/freezer has a lock and restrict key access to only authorized RAM users. Alternatively, a lockable box that can be secured inside of the refrigerator/freezer will suffice. If neither of these are in place, you will be asked how you are able to ensure that individuals who have a key to your lab but are not authorized RAM users are prevented from accessing your RAM stocks.
- *Appropriate shielding should be in place to reduce exposure.* If the outer container, or pig, does not provide adequate shielding, then you must store the stock vials in another container that will. Lead is recommended for strong gammas, such as I-131, while 3/8" acrylic will provide adequate shielding for high energy beta emitters like P-32.

In addition to these considerations, it is strongly recommended that you store RAM stock vials inside of a plastic or acrylic box/tub to prevent contamination should the vial be tipped over and leak.

## 5.c: Removal from Inventory

When inspections of your RAM lab(s) are performed, current inventory lists will be printed using information in the URC Assistant. Inspectors will use this list to verify your inventory. PIs must be able to account for all RAM that is/was in their possession.

## 5.c.1: Use/Disposal Logs

PIs are required to keep their online inventory database up to date. This includes logging uses of unsealed RAM and recording what portion of it went into waste.

When Radiation Safety personnel check in a RAM package, it is released to the PI with a package receipt and disposal record. This disposition sheet should be used to record the date and amount of each use, and what kind of waste was generated during the use. This information should be recorded for each use, and ultimately be entered into the URC Assistant database within a few days of the actual use.

## 5.c.2: Transfer of Unsealed Sources to Another RAM PI

In most cases, RAM inventory will be disposed of. In some cases, however, a PI may choose to transfer his/her RAM inventory to another PI who is approved to use it. This is allowed, but Radiation Safety personnel must be consulted and will coordinate the inventory change within the URC Assistant and actual transfer of RAM to the receiving PI.

## 5.c.3: Unsealed Source Inventory is Leaving Campus

In general, this does not occur. In the event that a PI would want to consider this, it would need to be coordinated through the Radiation Safety Office. It will take time to verify that the receiving organization has the required license to possess and use the RAM, and shipping and transportation would need to be in compliance with ODOT/USDOT regulations (see Section 10).

***Under no circumstances can OSU's RAM inventory be sold! ***

# Section 6: RAM Waste

Generation of radioactive waste is a part of every procedure that involves unsealed sources. As transportation and disposal of RAM waste is highly regulated and costly, it is important to minimize the amount of waste generated and, when possible, limit the chemical components of the waste to those that are aqueous.

## 6.a: Generation and Storage of RAM Waste

Any lab that produces RAM waste must **separate dry waste from liquid waste** and be able to characterize the following:

- ***Identification of the radioisotope*** – all waste containers must be marked with the radioisotope they contain. This marking must be easily seen and identified. RAM waste is not allowed to contain multiple radioisotopes unless the mixed waste meets the criteria described in Section 6.b.2 below.
- ***Approximate activity of radioisotope in the waste container*** – this can be reflected on the inventory verification form provided with stock vials until the container is sealed. However, when you enter a RAM waste pickup request (see Section 6.b) you must be able to provide an estimate of the total activity within the container.
- ***Date of starting and date of closure of waste container*** – start date should be written on the waste container when it is put into use. Radiation Safety personnel will indicate the date of closure when they pack and tag the container for removal.
- ***Chemical components of liquid waste*** – chemical components will be evaluated to determine if contents are aqueous or organic, and for any

other chemical that may need to be identified for hazardous materials identification. This information will need to be entered into the URC Assistant.

- ***Any non-RAM hazards, i.e. sharps or glass, that might exist in dry waste*** – this information will need to be entered into the URC Assistant.

**<u>*RAM waste should not be autoclaved.</u>** If your procedure includes tissue culture and generated RAM waste will contain a biohazard component, you must disinfect the biohazard component using bleach (or other approved disinfectant) prior to placing the waste in RAM waste containers. If a situation arises where this is unavoidable you must notify the RSO and have him/her coordinate and oversee the autoclaving process. Common use/departmental autoclaves are not approved RAM equipment and will not be used for any RAM waste.

### 6.b: Disposal of RAM Waste

In general, disposal of RAM waste should only be completed by Radiation Safety personnel. The only exception to this is certain sewer disposals, so long as they adhere to requirements outlined in Section 6.b.3. However, PIs must ensure that RAM waste from their labs is collected and separated as outlined in Section 6.a in order to facilitate the eventual disposal of RAM waste.

## 6.b.1: Decay in Storage Waste

Decay in storage waste, or DIS waste, refers to waste that contains short-lived radioisotopes. Per OSU's license agreement, OSU can hold DIS waste for radioisotopes with half-lives less than 90 days for 10 half-lives. After this 10-half-

life holding period, if a survey of the waste reflects that there is no radioactivity remaining then the waste can be disposed of as non-radioactive. However, this requires that all RAM labels and radioisotope identifiers be removed or defaced.

Any lab that produces DIS waste must ensure the following:

1. All RAM labels in dry waste containers have been defaced/blacked out. This includes vials, stock vials, and RAM tape on bench paper.
2. All radioisotope identifications have been defaced/blacked out. This includes vials, stock vials, and test tubes.
3. No broken glass, needles, or other sharps should be present in DIS dry waste containers.

## 6.b.2: Mixed Isotope Waste

Only H-3 and C-14 waste can be combined into a single waste container without prior authorization from the Radiation Safety Office. Dry and liquid waste must still be kept separate.

## 6.b.3: Sewer Disposals

Sewer disposals may be performed by PIs, so long as they are in compliance with OSU's **Sewer Disposal Policy**. Records must be kept, and disposals must be reported in the URC Assistant accordingly.

Radiation Safety personnel are available to evaluate your aqueous liquid waste for sewer disposal options. If a PI is uncomfortable performing a sewer disposal, or if

the disposal would not meet the criteria in the **Sewer Disposal Policy**, you can contact the Radiation Safety Office for assistance.

## 6.b.4: RAM Hazardous Materials Waste

PIs can request a pickup of RAM waste containers via the URC Assistant. Upon such a request, Radiation Safety personnel will come to your lab to ensure all markings and labels are present, then seal and tag your waste for pickup by Environmental Health and Safety (EHS) personnel. This process can generally be completed within one to two weeks.

# Section 7: Contamination Surveys

Any laboratory where unsealed sources of RAM are used and stored must be monitored routinely to ensure that no contamination is present. PIs must ensure that appropriate instruments are available to survey for the radioisotope(s) being used, and that routine surveys are performed as outlined below.

## 7.a: Survey Instruments

In laboratories where unsealed sources are used, PIs will need to have access to an appropriate wipe counter and, in some cases, a portable survey instrument. All instruments that will be used for area surveys will need to have a current efficiency (must establish efficiency annually) determined for each radioisotope they will be surveying for. **Survey instrument readings without converting cpm to dpm (or pCi, nCi, uCi, etc.) using current efficiencies are not acceptable survey records.** Contact the Radiation Safety Office for more information, or if you have questions regarding these required conversions.

### 7.a.1: Portable Survey Instruments

The portable survey meter used in most unsealed source RAM laboratories is a Geiger Mueller survey meter, commonly referred to as a Geiger counter or GM survey meter. While Geiger counters have some limitations with regard to the radioisotopes, they are able to detect, in unsealed source laboratories where radioisotopes that are detectable with these instruments are used, they can play a vital role in minimizing contamination.

Efficiencies can be determined by Radiation Safety personnel every June. You will receive a letter indicating when you may drop off your survey meter for these procedures. There is a calculation for converting cpm to dpm and uCi in the RAM notebook provided to you by the Radiation Safety Office. Raw, or unconverted, counts are not acceptable records.

Geiger counters are required for users of P-32, and strongly recommended for users of C-14 and S-35. Geiger counters will not be able to detect H-3. Users of other unsealed sources will need to check with the Radiation Safety Office to find out if a Geiger counter will be required or may be useful for the radioisotope with which they will work.

**Geiger counters can be used for post-use surveys & must be documented:**

1. You are using an isotope that can be detected with the survey meter, AND
2. You know the appropriate beta efficiency for your survey meter for the radioisotope you are measuring to verify that no contamination is found. If the Geiger counter survey indicates contamination does exist, then wipes must be done to quantify contamination levels, or invalidate Geiger counter results.

## 7.a.2: Wipe Counters

All RAM PIs must have access to a wipe counter. This is usually a liquid scintillation counter (LSC) but may also be a gamma counter for those who use I-125.

Efficiencies for the radioisotope(s) you will survey for will need to be determined on an annual basis. There is a method for determining the efficiency of a wipe

counter using small amounts of your RAM stock, and the calculation for converting cpm to dpm and uCi is in the RAM notebook (see Section 11.a) provided to you by the Radiation Safety Office. Raw, or unconverted, counts are not acceptable records. If your counter will convert the data for you and report in dpm, then you must have the efficiency and date it was determined readily available.

## 7.b: Post-Use Contamination Surveys

**The purpose of a post-use contamination survey is to verify that the work area and equipment used during the procedure were not contaminated with RAM.** These work areas and the equipment used during RAM procedures must be surveyed for contamination at the end of *each day that unsealed sources were used*. If a single procedure spans multiple days, then surveys must be performed and recorded for each day.

If contamination is indicated when using a Geiger counter (or other portable survey instrument), wipes must be taken of the area to quantify levels of contamination. A good rule of thumb is that if you get readings that are more than twice background, you should do a wipe test to verify/quantify contamination. If this occurs, you need to include appropriate records from both the Geiger counter survey and the wipe counter survey in this record.

## 7.c: Monthly Contamination Surveys

**The purpose of a monthly contamination survey is to ensure that RAM stocks and waste are not leaking.** If RAM stocks are present in your laboratory, you must perform wipe tests on the outside of RAM stock containers (do NOT open pigs, just wipe the outside of them). If RAM waste is present in your lab, you must perform wipe tests on the outside of waste containers and the floor/bench around the bottom of the containers.

Portable survey meters may NOT be used for monthly contamination surveys because there is no way to discern whether a positive reading is from contamination, or from the RAM inside of the containers.

## 7.d: Survey Records

The Radiation Safety Office can customize a spreadsheet that will convert cpm data to pCi amounts and record all of the required data (excluding the map and raw data) that you can update as needed. Contact Radiation Safety personnel if you do not already have one of these spreadsheets.

Records of all surveys will need to include the following:

- Radioisotope(s) you are surveying for;
- Survey instrument used, including:
    - Serial number;
    - Efficiency (cpm/dpm or cpm/"x" Ci) for appropriate radioisotope;
    - Date efficiency was determined (should not be more than one year old);
- Initials of person performing the survey;
- Layout/map of area and equipment surveyed with Geiger counter surveyed areas (post-use surveys only) or wiped areas identified;

- Raw data should be reported as one of the following, depending on what kind of survey instrument you are using:
    - If using a Geiger counter (post-use surveys only) you can report that readings of surveyed were "≤ BKGD", if readings are above background levels report total cpm (see below for follow-up actions required if you get readings more than 2X background levels);
    - If using a wipe counter, include the printout from the instrument;
- Conversion of cpm data to dpm or uCi (or pCi, nCi, etc.).

## 7.e: When Contamination Surveys Indicate Contamination Has Occurred

If your wipe survey identifies an area of contamination, there are several factors to consider. The following table is on the spreadsheet that the Radiation Safety Office can customize for your laboratory. If you do not have one, please contact the Radiation Safety Office to have one made for you.

| INTERPRETATION OF RESULTS | | |
|---|---|---|
| **Column** | **What it means** | **What should you do?** |
| Activity (pCi) | This is the calculated activity in pCi detected on the swipe. | If this number is > 100, you must call the RSO. If this number is > 25, you should consider cleaning the area/ equipment. |
| Above MDA? | Minimum Detectable Activity - this is the lowest amount of activity that your counter can detect that is statistically above background levels. | If "YES" appears in any of the darker orange columns in the fourth table, you might consider cleaning the area/ equipment that was swiped. |
| Total pCi | This is the sum of pCi from all channels (if multiple channels were used). | If this number is > 100, you must call the RSO. If this number is > 25, you should consider cleaning the area/ equipment. |
| Call RSO? | You are required to notify the RSO in the event that contamination is found to be at or over 100 pCi. | If "YES" appears in this column, you must notify your PI and the RSO. |

If you determine that you should/must clean a work area, you must document the cleaning efforts and include post-cleaning survey records that include all of the documentation outlined in Section 7.d.

There are two scenarios in which you **must** notify the Radiation Safety Office of contamination.

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1. If you find levels in excess of 100 pCi (220 dpm) per 100 $cm^2$ you are required to notify the Radiation Safety Office.
2. If you find contamination less than 100 pCi (220 dpm) per 100 $cm^2$ and tried to clean it, but your post-clean-up wipes indicate that contamination is still present then you must notify the Radiation Safety Office.

You are also encouraged to contact the Radiation Safety Office any time you are unsure of how to interpret results. Radiation Safety personnel are available to assist with determining how to proceed.

# Section 8: Personnel Safety

A primary concern for any RAM laboratory should be the safety of RAM and non-RAM personnel. All users of unsealed sources must work in such a manner as to keep their own exposure and that of others **A**s **L**ow **A**s **R**easonably **A**chievable (ALARA). In order to follow the ALARA principle, users must be aware of the specific radiation hazards associated with the radioisotope with which they will be working. These risks are dependent upon the type of radiation emitted and the total activity of the sealed source. It is the PI's responsibility to understand these radiation hazards and subsequently ensure that all users are well trained on how to minimize them. This information should be incorporated into the Lab Specific Training (LST) that is specific to the procedure(s) performed with the specific radioisotopes being used. See Section 9.b for more information on LST.

Students, faculty, and staff who use unsealed sources should have a general understanding of RAM safety, but they also need to know the steps to take to avoid the hazards presented by the specific radioisotope with which they will work, and what steps can be taken to reduce risks of contamination and exposure while performing their RAM procedure.

**The most important aspect of personnel safety is proper training. See Section 9 of this handbook, which covers training requirements.**

The following subsections will provide safety precautions that should be taken specifically when working with unsealed sources of RAM. For additional information on general laboratory safety precautions refer to the OSU **Laboratory Safety Manual** as provided by the Environmental Health & Safety (EHS) office.

## 8.a: Proper Handling to Reduce Risk of Spilling and Contamination

The following list will provide some basic RAM safety practices that should be followed as well as some radioisotope-specific information.

- A minimum of gloves, full length pants/skirt, and a lab coat must be worn at all times when working with unsealed sources.
- Eye protection should be seriously considered when splashing is possible, though every effort should be made to reduce the possibility of splashing.
- All RAM work areas should be lined with absorbent bench paper and have RAM tape/labels that clearly identify the area as a RAM work area.
- All equipment, shielding, pipettors, tip boxes, etc. in the work area should be labeled with RAM tape and should remain in the work area until they have been wipe tested and verified to be free of contamination.
- Any portable instruments or supplies that are labeled with RAM tape must remain in the labeled RAM work area. If they have been wipe tested and verified to be free of contamination, you must remove the RAM label before taking it out of the RAM work area.
- Work with the stock vial as little as possible, as this is the most concentrated activity, and therefore the highest risk of exposure.
- Always change your gloves after handling the stock vial.
- Have a Geiger counter turned on and set to the side of the RAM work area when working with C-14, S-35, or P-32. Hold your gloved-fingertips in front of the detector (do NOT touch the detector!) after you've handled any stock or working solutions to verify they are not contaminated.

    - Note that Geiger counters may not be sensitive enough to detect dilute concentrations of C-14 or S-35. As such, you should change your gloves after handling diluted/working solutions just to be sure you are not spreading contamination.
- H-3 cannot be detected with a Geiger counter, so it is highly recommended that you change your gloves after you handle a RAM solution (either a stock vial or a
- diluted/working solution) and any time you have reason to believe that they *may be* contaminated.
- Always use a funnel when pouring large volumes of RAM solutions or transferring liquid RAM solutions to the appropriate waste container. The funnel should be labeled with RAM tape and stay in the RAM work area until it has been cleaned and verified to be free of contamination.

## 8.b: Mitigation of Exposure to Radiation

The three major factors in reducing exposure and following the ALARA principle while working with RAM are **TIME, DISTANCE** and **SHIELDING**. These factors will have a significant impact, either good or bad, on your overall exposure during RAM procedures. To reduce your exposure, use them as follows:

1. **<u>Reduce time</u>** spent working with RAM, especially concentrated solutions like stock vials. The less time you spend around RAM sources, the less exposure you have. Ways to achieve this include:
    a. Working with/around the stock vial as little as possible. If your stock vial must thaw, let it thaw in a shielded container within the work area. Prepare your tubes and containers to make your working

b. solutions ***before*** you open the stock vial. Once you have made your working solutions, close the stock vial and put it back in storage.
c. Familiarizing yourself with the entire procedure ***before*** you begin working with RAM. For complicated procedures, or those where timing needs to be determined, perform a dry run of the procedure without RAM so that you know when the best time is to bring the stock vial out, and how much time each step will take. Having a step-by-step outline of the procedure readily available to keep track of where you are and what step is next is always a good idea.
d. Working efficiently. Do not rush but keep hands-on processes with RAM solutions to a minimum. Again, a dry run without RAM reagents whenever you perform a new procedure is very beneficial in this regard.

2. **Increase distance** between yourself and the RAM solutions. Radiation exposure is inversely proportional to the square of the distance between the object being exposed (i.e. *you*) and the source of radiation. In other words, twice the distance equals one quarter of the exposure.
3. **Use shielding** whenever possible and practical. Shielding recommendations and requirements are dependent upon radioisotope(s) being used and procedures being performed. For instance, if your procedure involves a needle, you would not want to use shielding that restricts body movement and dexterity as it could increase the risk of a needle stick. Such factors should be considered when determining when and what type of shielding will be used. A list of the commonly used unsealed sources on the OSU campus and their shielding requirements follows.
    a. **H-3:** No shielding requirements.
    b. **C-14, P-33** and **S-35:** Acrylic or Plexiglas is recommended when working with the stock vials whenever possible. Working solutions
    c. are typically at low enough concentrations that exposure rates are minimal without shielding.
    d. **P-32:** 3/8” acrylic or Plexiglas should be used whenever it is practical to do so.

e. Shielding requirements for unsealed gamma emitters should be determined on a case-by-case basis, though RIA kits will not require shielding. Contact Radiation Safety Office personnel for assistance in determining what, if any, shielding should be used during your procedure.

## 8.c: Monitoring User Radiation Exposure

Radiation Safety personnel will determine the need for monitoring user radiation exposures. Such decisions will be based on regulatory requirements and institutional policies. If it is determined that such monitoring is necessary, PIs and other unsealed source users must adhere to the prescribed methods of monitoring.

## 8.c.1: Dosimetry

In general, only P-32 users will require both body and ring dosimeters. However, Radiation Safety personnel may determine that the quantities of radioisotopes being used and/or procedures being performed using other radioisotopes will require ring and/or body dosimeters be worn by all users. **PIs are responsible for funding appropriate dosimetry for unsealed source users working within facilities they manage or are responsible for. See RSO Dosimeter Billing Policy for billing information.**

## 8.c.2: Bioassays

In some cases, bioassays will be required in order to monitor the potential uptake of a radioisotope during a routine procedure, specifically radioiodine compounds (see NRC's **Regulatory Guide 8.20**) and tritium (see NRC's **Regulatory Guide 8.32**). These Bioassays will be performed by the Radiation Safety Office.

## 8.c.3: Air Sampling

Radiation Safety personnel may perform air sampling tests in certain cases to verify and document that additional PPE and/or bioassays are not required.

# Section 9: Training for Users

If the use of an unsealed source requires approval of a procedure to be on file with the Radiation Safety Office (see Section 2), then all users of the unsealed source must be adequately trained prior to working with RAM.

## 9.a: Online Training

Everyone who plans to use RAM is required to complete the online training provided by the Radiation Safety Office. Radiation Safety Training Request Forms are available on the Radiation Safety website and should be submitted to the Radiation Safety Office *via* campus mail or e-mail.

There are several online training courses provided by the Radiation Safety Office, but only two are required of unsealed source users and PIs.

- The RAM – Unsealed Sources training course is required of all unsealed source PIs and users. This training consists of a series of slides and a subsequent quiz, which must be completed every two years.
- The PI Responsibilities training is required for all RAM PIs. This training consists of a series of slides followed by an acknowledgement that the trainee has read and understood his/her responsibilities as a PI. This is a one-time training that is required of all RAM PIs.

## 9.b: Lab Specific Training

RAM PIs are responsible for training their users on the specific hazards of their procedures that include unsealed sources of RAM. This is completed via lab specific training, or LST. Users need to understand the specific hazards associated with the radioisotope(s) with which they will be working, and how to minimize their overall exposure. They should understand the need to segregate waste: RAM from non-RAM, solid from liquid, and separation of radioisotopes. They should be able to use a survey meter, if applicable, to monitor for contamination during and after procedures. It is also important that all users understand how to properly document uses, contamination surveys, and what to do in the event of contamination and/or exposure.

LST is a required portion of the RAM use application and is ultimately approved by the RSC. If LST is updated between application approvals, it must be approved by the RSO.
LST must be completed by all users on an annual basis. PIs must have documentation of LST for all users readily available for review upon request. Because PIs create their own LST and are expected to know and teach their users how to perform the procedures, while mitigating the risks of exposure and contamination, PIs do not need to complete the LST.

Because the Radiation Safety Office tracks LST (see Section 9.a), copies of all completed LST must be submitted to the Radiation Safety Office. All LST documents must be signed by both the PI (or other approved trainer) and the trainee. The document must also be dated in order to be valid.

LST will not be required of any PI who indicates in his/her application that he/she will be the only person who will use/have access to the RAM in their laboratory. However, LST must be submitted to and approved by Radiation Safety Office personnel if additional users are added to the PI's permit.

## 9c: Non-User Training

In some cases, RAM PIs will have people who work in or have access to their RAM labs, but do not use the RAM. In these situations, it is prudent to identify these workers as "non-users" and document their "training" by having them sign a statement of non-use. This will document that the user has been instructed that there is unsealed RAM in their work area, and that they are not authorized to use/handle the RAM until further notice from the PI. The Radiation Safety Office can provide a non-user statement.

While a RAM PI may request a non-user status and training for any of his/her workers as deemed necessary, they are typically given this status when they meet one or more of the following criteria:

- Worker has access to the lab where unsealed RAM is located/used;
- Workers may be present when unsealed RAM is being used.

The training requirements for non-users are as follows:

1. Signed statement of non-use – one-time only, not required to be repeated but the statement document must be approved by the Radiation Safety Office.

2. Online training – is not required by the Radiation Safety Office, but the PI may choose to have the non-user take the online Unsealed RAM Training. If such requirements are requested, the non-user will be required to repeat the training every two years. Non-User Training Request Forms can be obtained from the Radiation Safety Office.

## 9.c: Other Training Requirements

It is rare that additional training will be required for unsealed source users. However, if the Radiation Safety Office institutes additional training requirements for your procedure(s) these requirements will be explained to you.

# Section 10: Transportation and Shipping

The USDOT considers most[1] RAM to be hazardous materials; therefore, all aspects of vehicular transportation of RAM[1] on public-access roadways is regulated by USDOT and ODOT. Contact Radiation Safety Office personnel for information on how to ship/transport unsealed sources.

*Under no circumstances should vehicular transportation of any RAM be attempted by persons who are not certified to participate in hazardous materials transportation.*

[1] There are very small quantities of RAM that may be transported without shipping papers, but other factors must be considered in order for this DOT exemption to apply. To avoid potential personal and/or institutional fines, you should never attempt to transport RAM without consulting the Radiation Safety Office.

# Section 11: Inspections

Radiation Safety Office personnel will inspect and survey all approved unsealed source laboratories on the OSU-Stillwater & OSU-Tulsa campus.

## 11.a: Initial Inspections

**Any new regulated unsealed source or RAM must be approved by the RSC (or RSO if applicable) before it can be used.** Part of the approval process is the inspection of the proposed location by Radiation Safety Office personnel.

Initial inspections will be performed for any new unsealed source laboratory on the OSU campus. A RAM notebook will be provided to the PI, for record keeping purposes, by Radiation Safety Office personnel. This notebook will have the following sections:

- **RSO Training Certificates**: Current training certificates should be maintained in the notebook and readily available for review upon request.
- **Lab Specific Training Documentation**: Current LST documentation for all users should be retained in the notebook and readily available for review upon request.
- **Survey Equipment Calibration and Efficiency Information**: All survey instruments must be calibrated or have efficiencies determined at least once per year (see Section 7.a). Current calibration and efficiency records must be maintained and be readily available for review upon request.
- **RSO Inspections and Quarterly Reports:** These should be maintained in the PI's records and referenced as needed.

- **Current RAM Applications and Approvals:** These should be maintained in the PI's records and referenced as needed.
- **Monthly Contamination Surveys:** All monthly contamination surveys should be properly documented as described in Section 7.d. All records should be maintained in the notebook and readily available for review upon request.
- **Inventory Disposition Sheets:** These documents are provided to you by the Radiation Safety Office, once your package has been checked in. Users should record each use of the indicated stock vial and indicate what kind of waste was generated. This information should then be entered into the URC Assistant database to keep the online inventory up to date. If your users have direct access to your online inventory, then this step can be skipped. However, you must always be able to access up-to-date records of your inventory upon request. Contact Radiation Safety personnel to make arrangements for your users to have access to your online inventory, if desired.
- **Usage Contamination Surveys:** All usage contamination surveys should be properly documented as described in Section 7.d. All records should be maintained in the notebook and readily available for review upon request.

The initial inspection may require multiple visits by Radiation Safety Office personnel to ensure all survey equipment, shielding, and security requirements have been met. Additionally, specific signage and notices must be posted by Radiation Safety Office personnel.

## 11.b: Annual Inspections

All approved RAM laboratories on the OSU-Stillwater & OSU-Tulsa campus must be inspected once per year at a minimum. Radiation Safety Office inspectors will

verify that regulatory requirements are being met. These regulatory requirements include, but are not limited to:

- RAM facility has the required postings in clear view;
- RAM work areas and equipment are properly labeled;
- Calibration and efficiency information is current (no more than 1 year old) for all survey instruments;
- Fume hoods, laminar flow hoods, and biosafety cabinets that are labeled for RAM use must be kept in current calibration (no more than one year old) or they will not be allowed to be used for RAM procedures;
- Waste containers are out of the way and marked as required (see Section 6);
- Inventory verification – you must be able to locate and show all stock vials that are on your online inventory;
- Unsealed source vials are secured from unauthorized access, as described in the approved application;
- Use of unsealed sources is consistent with that described in current approved applications;
- Required PPE being worn;
- No food, drinks, medications, cosmetics, etc. are in the lab;
- Dosimeters, if applicable, are being used properly;
- Sewer disposals, if applicable, are being properly documented;
- Contamination surveys are being performed and properly documented. Radiation Safety personnel will compare several recorded dates of use with dates of your usage contamination surveys to ensure that they are being performed as required.
- Online and lab specific training records are up-to-date and readily available;

- If a survey meter is used in your lab, a user, not a PI, will be asked to demonstrate how he/she would go about doing a post-use survey

Upon the scheduling of annual inspections, Radiation Safety Office personnel will send the PI a copy of his/her current inventory and a list of users and each users' training due date(s). If updates are required, it is best if the PI can address these prior to an inspection in order to expedite the inspection process.

If Radiation Safety personnel identify items during an inspection that need to be addressed, the PI will receive an e-mail message listing the concerns and the corrective actions that must be taken. Upon completion of addressing all listed corrective actions, the PI will receive a signed inspection report from the RSO for his/her records.

*If a RAM PI does not schedule his/her annual inspection or does not comply with corrective actions in a timely manner, the RSO will place restrictions on his/her RAM permit that may include inactivation of the PI's RAM permit and/or removal of purchasing privileges until the inspection is completed and all corrective actions have been adequately addressed.

# Section 12: Radiation Safety Office and Radiation Safety Committee Responsibilities

The Radiation Safety Office is managed by the RSO, who is charged with providing guidance and support to OSU faculty, staff, and students who use RAM in their research and instructional activities. With the help and support of the RSC, the RSO works to ensure that applicable policies, safety standards, and regulations are being met. The RSO, with the assistance of his/her staff, will inspect RAM laboratories no less than once per year. Other inspections may be scheduled as deemed necessary by the RSO.

The RSO will report overall inspection findings and trends to the RSC, which is composed of OSU faculty, a physician from University Health Services, a representative from OSU executive management, and the RSO. This committee works with executive management and the RSO to implement the Radiation Safety program and establish policies and procedures for managing the Radiation Safety program.

The RSO is ultimately charged with ensuring that activities involving RAM are performed safely utilizing best practices on the OSU-Stillwater and OSU-Tulsa campuses. **The RSO ensures that each RAM PI is operating in compliance with regulations so that OSU's RAM permits, which are issued by ODEQ, are not adversely affected.**

## 12.a: Quarterly reports

Radiation Safety Office personnel will distribute reports to RAM PIs every three months (i.e. quarterly). These reports will list the current RAM inventory, approved lab locations, and the training status of all authorized RAM users listed on the PI's permit. PIs will need to do the following with each report:

1. Note any changes in authorized users in the report and provide updated LST for users, if required - make note of impending training due dates for all personnel, including him/herself.
2. Verify that the RAM inventory is accurately reflected. If they are not, he/she will need to update the online inventory and make a note on the quarterly report that the inventory item has been updated online.
3. Sign the report and return it to the Radiation Safety Office.

These reports will allow the PI to verify that the information on file with the Radiation Safety Office is accurate and up to date. By signing a quarterly report, he/she is verifying that all the information contained within the report is accurate. If it is NOT accurate and you require assistance in determining the best way to make corrections, please call the Radiation Safety Office.

## 12.b: Radiation Safety Office as a Resource for Principal Investigators

Radiation Safety Office personnel strive to guide and assist faculty, staff and students in conducting activities involving RAM in such a way that the safety risks to RAM users, and non-users alike, are minimized. It is the goal of Radiation Safety Office personnel and the RSC to work ***with*** RAM PIs to ensure that activities involving the use of RAM continues, while promoting safety and compliance with pertinent regulations, policies, and best practices.

Questions about RAM regulations and procedures can be e-mailed to radsafe@okstate.edu.
Radiation Safety Committee contact information can be found here.