

# RADIATION SAFETY MANUAL



2014



**SAFE WESTERN PROJECT**  
HEALTHY AND SAFE 24/7



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# Acronyms

Annual Limit on Intake (ALI)  
As Low As Reasonably Achievable (ALARA)  
Authorized Users (AUR)  
Carbon-14 (C-14)  
Derived Air Concentration (DAC)  
Geiger Muller (GM)  
Hydrogen-3 (H-3)  
Liquid Scintillation Counter (LSC)  
Nickel 63 (Ni-63)  
Radioactive Material License WN-C007-1 (License)  
Radiation Safety Officer (RSO)  
Radioactive material (RAM)  
Sulfur 35 (S-35)  
Tritium (H-3)  
U.S. Department of Transportation (DOT)  
U.S. Nuclear Regulatory Commission (NRC)  
Washington State Administrative Code for Radiation Protection (WAC 246)  
Washington State Department of Health, Office of Radiation Protection (DOH)  
Western Washington University (WWU)

# 1.0 Organizational Structure

## 1.1 Radiation Safety Organization

Western Washington University's (WWU) uses both radioactive material and x-ray generating machines for research and classroom instruction. The use of radioactive material is authorized by radioactive materials license WN-C007-1 (License) issued by the Washington State Department of Health, Office of Radiation Protection (DOH). The State's authority is derived from federal legislation and a formal agreement between the Nuclear Regulatory Commission, a federal agency, and DOH. The use of radiation generation machines for analytical purposes is registered by DOH through authority established in the Revised Code of Washington (RCW) Title 70.98.050 and outlined in the Washington Administrative Code.

For radioactive material use, WWU has a "specific license" for work as a "medium laboratory". The License allows possession and use of radioactive materials as well as specifying conditions for use, listing Authorized Users, and designating the Radiation Safety Officer (RSO). The nature of a "specific license" requires that any proposed change to WWU's radioactive materials license must be submitted to DOH for review and approval. DOH reviews and approves any changes to the license. .

For use of x-ray generating machines, WWU has a registration for an x-ray diffractometer. This is an analytical instrument that measures x-ray diffraction or reflection from solid materials. It is used to identify compounds and measure thicknesses of thin smooth films. Additionally, it is used to teach students how to measure lattice parameters of crystalline materials. As with radioactive material use, DOH must approve any additional x-ray generating machines prior to their purchase and use at WWU.

For both of these programs, the fundamental responsibilities of the RSO are to review and recommend policies and procedures with respect to radiation safety. The RSO also monitors the use of radioactive materials and x-ray generating machines at WWU. While the radiation safety program is under the general administrative jurisdiction of the University's Vice President for Business and Financial Affairs, the responsibilities for administration, staffing, and budgeting for the radiation safety program are handled by the RSO.

In the final analysis:

**The individual Authorized User is responsible for the safe conduct of his or her activities involving the use of radioactive materials and/or radiation-producing equipment as well as those of employees and students who may work for them.**

## 1.2 The Radiation Safety Officer

The RSO has had specific, formal training in radiological health, and experience in radiation protection, and with radioactive material. The RSO is responsible for carrying out the provisions within this manual and the Washington State Administrative Code (WAC) which covers Radiation Protection in WAC 246.

Specific duties of the RSO include (per License):

1. Assure that all uses of radioactive materials are conducted safely; adhere to the conditions of the University's license and license application; and result in exposures to personnel which are As Low As Reasonably Achievable (ALARA).

2. Assure that the radioactive materials possessed by WWU are limited to the types and possession quantities authorized by the University's license.
3. Be familiar with all applicable State and Federal regulations, and regulatory guides and standards.
4. Act as liaison with regulatory authorities; be available for assistance in inspections and audits by DOH, and notify DOH as follows:
  - a. In writing before making any changes which would render the Application for Radioactive Materials License, Radioactive Materials License, Application for Registration (of radiation producing machines) or Notice of Registration no longer accurate.
  - b. Immediately in the event of any radiation accident or incident (including high dosimeter reading).
  - c. Within five (5) days of any positive leak test result of a sealed source; and/or
  - d. Within thirty (30) days in a report stating remedial action taken after accident or incident.
5. Assure that radioactive materials are used only by or under supervision of individuals authorized by the license.
6. Assure that radioactive materials are secured against access by unauthorized persons and/or unauthorized removal.
7. Maintain a running inventory of all radioactive material possessed under the license, including radioactive waste.
8. Assure that a semi-annual inventory of all sealed sources possessed by WWU is performed.
9. Post "Notice to Employees" RHF-3 and notices of items of non-compliance resulting from WA State Department of Health inspections conspicuously, in an area where users of radioactivity will see them.
10. Assure that radiation workers are instructed in and have documented training in radiation safety rules, procedures, and the ALARA program, including:
  - a. Prior to working with radioactive materials,
  - b. With each change in license condition or in the safety program, and
  - c. Annually in a refresher course.
11. Train ancillary staff commensurate with duties, including posting and emergency procedures. (Refer to Section 16)
12. Assure that individuals working with radioactive materials have appropriate protective devices, including shielding, ventilation, clothing, gloves, remote handling equipment (where necessary), and facilities which aid in keeping exposures ALARA.
13. Perform a quarterly review of occupational doses to workers to determine if the doses are within the limits established for the ALARA program.
14. Perform an annual review of the radiation safety program for adherence to ALARA concepts and to make sure that the radiation safety program is followed by all workers dealing with radioactive materials.
15. Advise occupational workers of each high dose report, and conduct a survey to determine the cause of all overexposures so as to preclude reoccurrence.

16. Provide occupational workers documentation of their annual accrued dose from internal and external exposures.
17. Supply terminated occupational workers with radiation dose records as required by regulation.
18. Procure and maintain an adequate number of operable and properly calibrated radiation survey instruments/ counting equipment, of the appropriate range and type.
19. Assure all surveys, calibrations, and leak tests are performed on time.
20. Assure that all incoming and outgoing radioactive shipments are properly packaged and labeled according to U.S. Department of Transportation (DOT) requirements, and that shipments are accompanied by proper shipping papers.
21. Assure that radioactive materials are disposed properly.
22. Establish and maintain record systems as applicable for:
  - a. Radiation area surveys,
  - b. Leak tests,
  - c. Instrument Calibrations,
  - d. Personnel dosimeter reports,
  - e. Receipts of incoming radioactive material,
  - f. Surveys of incoming and outgoing radioactive material shipments,
  - g. Radioactive materials use and inventory,
  - h. Radioactive waste disposed,
  - i. Personnel training, and
  - j. Audits, incidents, and ALARA reviews.
23. Develop and maintain up-to-date operating and emergency procedures.
24. Take charge in all emergency situations (spills, or release of radioactive material, etc.) to make sure correct protection procedures and emergency decontamination procedures are carried out.
25. Investigate and implement corrective actions for incidents.
26. Investigate any deviation from the radiation safety program and take any remedial action necessary
27. Apprise and inform management of radiation safety status and their responsibilities in maintaining an adequate radiation safety program.

Additional responsibilities not specifically designated as part of the License include the following:

1. General surveillance and authority over all activities involving radioactive materials at WWU and its adjunct facilities.
2. Determining compliance of Authorized User programs with the rules, regulations and license conditions for the handling of radioactive materials.
3. Monitoring the ordering and receipt all shipments of radioactive materials arriving at the University.
4. Properly storing all radioactive materials not in current use, including wastes.
5. Terminate immediately any project that is found to be a threat to health or property, or in any way in violation of the University's license to handle radioactive materials.
6. Maintain other records not specifically designated above, e.g. receipt, transfer, and survey records, as required.

7. Inspect and survey, as necessary, laboratories and facilities where radioactive materials are used and/or stored.
8. Acquire as necessary current copies of regulations, codes, rules and reference materials, and maintain a library of relevant documents.
9. Assure that individuals working with radiation have appropriate protective devices, including shielding, ventilation, clothing, gloves, remote handling equipment (where necessary), and facilities which aid in keeping exposures ALARA.
10. Procure and maintain an adequate number of operable and properly calibrated survey instruments of the appropriate range and type, and properly calibrated counting equipment.

### **1.3 Radiation-Producing Equipment**

Radiation producing equipment such as x-ray machines, x-ray spectrometers, etc., shall be under the jurisdiction of the Radiation Safety Officer.

Radiation-producing equipment shall be installed, maintained, and operated in accordance with WAC 246.

The Radiation Safety Officer will be notified of all plans to procure new radiation producing machines or plans to modify or move existing machines.

All Authorized Users of radiation producing machines must have proper training in the operation of the specific device and be familiar with the applicable safety requirements of WAC 246.

### **1.4 Authorization for Use**

Authorized User (AUR) - Any member of the University who has completed and filed the proper application with DOH and is named on WWU's license is an Authorized User of radioactive materials.

Student Users - Any student working under the supervision of an Authorized User, (on protocols which have been approved by DOH), who has completed radiation safety training. Graduate students' independent projects must be performed under the aegis of an Authorized User.

Employee Users - Any employee working under the supervision of an Authorized User, (on protocols which have been approved by DOH), who has completed radiation safety training.

Procedures for Obtaining Authorization - Any faculty member who wishes to use radioactive materials or radiation generating equipment must first obtain authorization through DOH via appropriate submissions to the RSO.

The RSO ascertains that there are adequate precautions taken by the applicant to assure the safety of the personnel involved, the general public, and the facilities. In addition, he/she ascertains whether the applicant has adequate training, experience, equipment, and facilities to safely conduct the experiment or operation.

The Radiation Safety Officer may request additional information from the applicant to assist in the decision making process. Upon review, the RSO submits a license amendment request to DOH. The applicant will be informed in writing by the RSO, of the disposition of his or her application.

The authorization will be specific for the type of radiation or radioactive material, possession and use limits, location of use, chemical compound or form, and type of use. An application for amendment to the authorization may be necessary when programs change.

The RSO may restrict or forbid the use of any radiation that is not used within or according to proper authorization. If any aspect of a properly authorized procedure presents an unrecognized hazard, the RSO may stop the procedure and require a re-evaluation by DOH.

Substantial changes in an Authorized User's protocols or use of radioactive material and/or radiation generators shall be submitted to the RSO and to DOH for evaluation prior to implementation.

## **1.5 Procedures for Terminating Authorization**

An authorization for use of radioactive material may be terminated for one of the following reasons:

End of Project: This procedure applies to users who have finished work with radioactive material, had their authorization expired, or who terminate employment. The Authorized User initiates the procedure 30 days in advance of any of the above.

1. Submit a letter to the Radiation Safety Officer requesting that the authorization be terminated. The letter shall state the disposition of the radioactive material.
2. The AUR makes a comprehensive survey of the laboratories and provides the results to the RSO, before said spaces are released for other use. In the event contamination is found, the AUR takes the necessary steps to remediate the facility.
3. The RSO surveys the area and forwards a written confirmation to the user that the laboratory has been surveyed and found to be clean and that the authorization is officially terminated.

Leave of Absence Procedure: This procedure shall be followed for all authorizations in which a leave of absence will occur. The Authorized User initiates the procedure at least 30 days prior to starting his or her leave of absence.

1. Transfer any on-hand radioactive material to an Authorized User remaining at work, to the Radiation Safety Officer, or otherwise arrange for proper temporary storage until said material can be used or disposed, according to established procedures.
2. A comprehensive survey of the laboratories shall be performed by the Radiation Safety Officer before releasing them for free use.
3. The authorization remains inactive until the user returns.
4. Upon return to the campus, the AUR contacts the RSO and may review WWU's regulations, become updated on any changes made during the absence, and review the authorization to determine if any changes might be required before he or she resumes work with the radioactive material. Such contacts are documented by the RSO.

## 1.6 Procedures for Becoming an Authorized User

A person, with or without previous experience with radiation, desiring to use radioactive material at WWU shall complete radiation safety training, or otherwise demonstrate his/her competence in handling radioactive materials (RAM), as required, by the Radiation Safety Officer.

An applicant desiring to use radioactive material shall submit a written request to the RSO. The proposal must include:

- The radionuclide(s) to be used,
- The activity per experiment,
- The maximum activity on hand at any one time,
- The maximum activity projected for use over a year, and
- A detailed description of the laboratory protocol, including safety precautions.
- The location where the experiments will be conducted.

The RSO performs an analysis of the proposal, submits a request for a license amendment to DOH and is notified, in writing, by DOH when amendment is completed (or if more information is needed). The RSO communicates this to the requestor.

## 1.7 Criteria to be used in Evaluating an Application

The Radiation Safety Officer evaluates the following:

- The need for personal dosimetry in relation to the project and WAC 246-221.
- The facilities for these elements:
  - Adequate security.
  - Limiting access to authorized persons only.
  - Containment of the radiation to prevent exposure to anyone beyond the confines of the facility.
  - Sufficient ventilation for volatile materials and for evacuating any airborne radioactive material that might be suspended in the room's atmosphere.
  - Provision of adequate, personnel protective equipment.
  - Provision of adequate spill containment and safety equipment, including remote handling tools, if needed.
  - Adequate shielding.
  - Adequate survey equipment.
- The credentials of the applicant to determine that:
  - The applicant has had sufficient training in the use of radioactive materials, and can assure that the radiation will be used safely.
  - The applicant has had practical experience working with radioisotopes so that the material requested can be used safely.

## 1.8 Amendments

Amendments are changes to WWU's License, including authorizations of radioactive materials users. Examples of some types of changes which can be approved by the RSO without a license amendment include (but are not limited to):

- Rearrangement of laboratory furniture.
- Change in storage location of radionuclides or wastes within a room.

- Changes in the amount of radionuclide authorized to be purchased, within the overall limits of the license. (Changes in amounts above the license limit must be approved by DOH, prior to implementation.)

## 1.9 Responsibilities of Authorized Users

**The AUR of radioactive materials or radiation producing equipment is directly responsible for all aspects of radiation safety associated with his or her possession and use of radioactive material or radiation sources.**

These responsibilities include but are not limited to:

1. Assuring that instructions on safe handling and proper radiation safety practices are provided to all persons working with radioactive material or radiation generating equipment who are supervised by, or who are within the facilities of the Authorized User.
2. Assuring that areas beyond the Authorized User's control are not affected by the Authorized User's use of radioactive material or radiation generating equipment.
3. Assuring that all necessary equipment and instructions for the proper use of the equipment are available.
4. Assuring that radioactive material, radiation generating equipment, and use areas are properly labeled and posted as required by this directive.
5. Assuring security against theft or unauthorized use of radioactive material.
6. Assuring that all radioactive waste is labeled and disposed properly, and in accordance with WWU requirements.
7. Notifying the RSO of any accident or abnormal incident involving, or suspected of involving, radioactive material or radiation generating machines.
8. Notifying the RSO of the intended transfer of radioactive material from the normal area of use to another Authorized User.
9. Maintaining accurate inventory records of radioactive material received, possessed, and disposed.
10. Arranging for transferring these responsibilities to another Authorized User during extended absences like sabbatical leaves or illnesses.
11. Complying with all applicable rules and regulations contained in WAC 246 and this manual. The Radiation Safety Officer provides information about applicable portions of WAC 246, as necessary, via web links to the Washington Administrative Code site.
12. Assuring that all students and faculty are familiar with the procedures of an experiment before using radioactive material or radiation-generating equipment.
13. Assuring that surveys are properly performed and assayed, and that the results are recorded in the laboratory log. A copy of the survey results are sent to the Radiation Safety Office within 7 days of the activity.
14. Being capable of being called on-site within a reasonable length of time, (one hour or less), when radioactive materials are being used by persons under his or her authorization; keeping such persons informed of the Authorized User whereabouts in case assistance is necessary; assuring that a second Authorized User will assume said responsibility, should the initial Authorized User not be available.
15. Stopping all use of radioactive material under his/her authorization in the event of not being available as specified above, unless a second Authorized User has agreed to assume the responsibilities for the experiment or operation.

16. Informing all persons under his or her authorization of all changes to procedures or regulations as they are received.
17. Insuring that all female employees involved with radiation generating equipment or radioactive material use have read NRC Regulatory Guide 8.13, "*Possible Health Risks to Children of Women Who are Exposed to Radiation During Pregnancy*", sign a statement confirming that each has read and understands the guide, and that a copy of the signed statement is on file in the Environmental Health and Safety Office.

For exempted amounts of radioactive material, a memorandum for the record will be prepared listing the material used, the operation performed, radiation level involved, and list the name and University number of each person involved. This memo will be filed with the Radiation Safety Officer.

18. Ensuring that all students who are allowed to work with radioactive material or radiation generating equipment are supervised. Students may not become Authorized Users but must do their work with guidance from an Authorized User.
19. Assuring radiation workers' doses are maintained as low as is reasonably achievable. In consultation with RSO, assuring ALARA principles are considered and incorporated into processes, facilities, and experiments.

## 2.0 Control of Procurement

### 2.1 Acquiring Radioactive Materials (RAM)

The purchase of all radioactive materials, (including exempt, generally licensed, and specifically licensed quantities, as well as "donations"), must be approved **in advance** by the RSO. Failure to comply with this requirement may result in suspension of the recipient's program, as it relates to radioactive materials.

The AUR notifies the RSO **prior to** the placement of an order for shipment of radioactive material. The RSO evaluates the request to ensure that the requested materials and quantities are (1) authorized by the license and that (2) possession limits are not exceeded by addition of the incoming material.

The RSO issues the AUR a specific WWU identification code number which is unique to each shipment of radioactive materials received at WWU. The AUR or a designee then completes the necessary purchase requisition or uses a p-card for purchase. **All WWU shipments of RAM must have an identification code issued by the Radiation Safety Officer.**

The RSO logs every purchase request and forwards necessary documents to the AUR or the Purchasing Department for processing. If there is a discrepancy in the order request, the initiator of the request is informed immediately.

The AUR or receiving personnel receives each package and ensures that it is secure at all times. If receiving personnel are the first to receive the package, they call the AUR or designee immediately to bring the package to the radioactive materials use area. The AUR or designee inspects and surveys the package as outlined below. Deliveries of RAM to WWU main campus departments and Shannon Point Marine Center are handled in the same manner.

WWU's current license does not permit deliveries of radioactive materials in excess of Type A quantity limits. Thus, survey procedures for Type A packages in accordance with WAC – 246 – 221 – 160 are not required.

For WWU shipments, the AUR or designee performs wipe tests of the exterior of the innermost package to insure no contamination is present. Assay of P-32 wipes may be performed using a calibrated Geiger-Mueller survey meter or liquid scintillation counter. Assay of wipes for H-3, C-14 and S-35 must be performed by using a liquid scintillation counter. Since radioactive materials packages have been shown to be contaminated especially on the inside container, it is essential that all personnel treat the packages as contaminated until they have been shown to be free of radioactive contamination. See 2.3 for detailed receipt survey procedures.

### 2.2 Receipt During Off-Duty Hours and Crushed or Leaking Packages

Radioactive materials may only be delivered to the University during "normal" working hours. The on-duty University Police are not available to receive packages. **All purchase orders must be marked "deliver only during normal business hours."**

If packages are crushed, wet, or in any way leaking, emergency procedures described in Section 21 of this document are followed. The Radiation Safety Officer or Environmental Health and Safety staff members are to be notified immediately.

If there is no damage evident in the packaging, the package is received and stored in a secure area. The Authorized User or his/her designee is notified as soon as is reasonably possible.

### 2.3 Receipt Inspection Procedures

Each package received is monitored for leakage and external contamination by an appropriate means for the particular radionuclide in question. For example, wipe tests are monitored by Geiger-Mueller survey meter for P32 or by a liquid scintillation counter for H-3, C14, or S-35. DOH will be

notified in accordance with regulations if removable contamination exceeds 2200 dpm/100 cm<sup>2</sup> or if external radiation levels exceed 50 mR/hr at the package surface or 10 mR/hr at three (3) feet (or 1m).

Due to the maximum possession limits of this license, no packages will be received containing quantities of radioactive material in excess of the Type A<sub>1</sub> or A<sub>2</sub> quantity limits found in [WAC 246-231-200](#). If this changes, the special procedures required for these packages would be followed in accordance with the requirements of [WAC 246-221-160](#).

For all shipments of packages containing radioactive material, the following procedures for opening are required:

- Wear disposable gloves to prevent hand contamination
- Visually inspect the package for sign of damage, e.g., wetness, crushing, etc. If damage is noted, stop opening and notify the Radiation Safety Officer.
  - **NOTE:** Handle the package carefully to contain any leakage.
- Measure the surface count rate or exposure rate and record it on the receipt document. (See Appendix 1 Form 1.b) For some radionuclides, this will mean a wipe test is performed on the exterior of the package and counted.
  - **NOTE:** If any unexpected radiation or contamination levels are detected, immediately stop, shield the package and notify the RSO.
  - Check for contamination on the external surfaces of any packages labeled with a radioactive white I, yellow II, or yellow III label, unless material is a gas, or special form as delineated on the packaging slip. If contamination on outer packaging is found, notify the RSO, who will notify DOH if appropriate.
- If no contamination is found on or at the surface of the package, open the package with the following precautionary steps:
  - Open the outer package, following the manufacturer's directions, if supplied, and remove the packing slip. Make a copy of the packing slip and send it to the RSO.
  - Open the inner package and verify that the contents listed on the outer source containers (pig) agree with those on the packing slip. Compare the requisition, packing slip and label on the outer container.
  - Take a wipe of the outer source container (the pig), check the wipe for contamination with an appropriate survey instrument or scintillation counter.
  - If the outer source container is not contaminated, open the outer container and check integrity of the final source container (i.e., inspect for breakage of seals or vials, loss of liquid, and discoloration of packaging material.)
- Monitor the empty package and packing materials for contamination with an appropriate survey instrument or take wipe samples for liquid scintillation counting before discarding.
  - If the packing is not contaminated, dispose of as normal waste. Remove all radiation marking symbols or obliterate them prior to disposal as normal trash.
  - If the packing is contaminated, dispose of it in the radioactive waste.
- Complete the Receipt of Radioactive Materials form (See Appendix 1 Form 1.b) and note counts or attach counting documentation. Maintain this information in the laboratory and send a copy to the Radiation Safety Officer.

No radioactive material is to be used until the required radiological surveys have been performed.

The Authorized User is responsible to maintain and follow procedures for safely opening packages containing radioactive materials.

## Back of Section 2

## **3.0 Inventory Control of Radioactive Materials**

### **3.1 Master Inventory File for Radioactive Materials (RAM)**

The Radiation Safety Officer (RSO) maintains records of all shipments of RAM both entering and exiting the university. Each shipment received by WWU is assigned a unique identification code, issued by the Radiation Safety Officer. This ID number is maintained with the shipment from receipt through disposal of the material. When waste is disposed, the radionuclide inventory is adjusted accordingly. Disposal of solid and liquid waste is performed only by Radiation Safety personnel unless the Authorized User has specific permission from the Radiation Safety Officer to do so.

### **3.2 Responsibilities of Authorized Users**

Each Authorized User is required to keep detailed records of radionuclides in her or his possession. These documents must accurately record consumption and disposition of the isotope. As the isotope is consumed through decay, entries must be made to reflect the decrease. As an isotope is used and placed in waste containers, records showing the contents of the waste container must be kept.

An audit trail must be created for each RAM ID number so that the Radiation Safety Officer or state inspector can trace the material and locate all portions of it, no matter whether it is in liquid waste, solid waste, biological waste, or the original container. The totals should closely approximate the original quantity received.

When all material from a RAM shipment is used, the AUR or designee completes a Disposition of Open Source Radioactive Materials (RAM) From Inventory form (see Appendix 1 Form 1.c) and provides a copy to the RSO, who marks the RAM log as disposed.

### **3.3 Reconciliation of Accounts**

During any time of operation, the RSO may request the AUR to compare radionuclide inventory records and reconcile the account. Failure to keep and maintain accurate records may be cause to terminate the authorized use of radioactive materials, by the individual concerned.

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## 4.0 Control of Areas in Which Radioactive Materials are Used or Stored

### 4.1 Restricted Areas

All radioactive materials must be used and stored in rooms or laboratories designated as **RESTRICTED AREAS**. All storage rooms and laboratories at WWU where radioactive materials are contained and used are designated on WWU's license to handle radioactive material.

A restricted area is "any area whose access is controlled by an Authorized User for purposes of protection of individuals from exposure to radiation and radioactive materials".

Authorized Users must insure that no unauthorized persons enter a restricted area. Visitors are permitted only if escorted by an Authorized User or his/her designee.

All radioactive materials are stored in secured areas. The keys must be controlled. Doors are to be locked when labs are unoccupied to assure that no unauthorized person has access.

Restricted areas must be kept clean and neat. Cleaning is done by or under the supervision of an Authorized User. Custodians are permitted to enter restricted radiation laboratories and/or storage areas to empty normal waste containers. They are instructed not to touch any laboratory benches, equipment, or other areas. They are not to handle any other item or area in a laboratory without an Authorized User, his/her designee or other knowledgeable supervisor present.

## Back of Section 4

## 5.0 Marking, Labeling, and Posting

Rooms, areas, and equipment where radioactive materials are used or stored shall be clearly marked with appropriately worded and designated standard radiation symbols as required under the conditions set forth in this section and in WAC 246.

WWU complies with all requirements for caution signs, labels, and instructions to personnel in WAC 246. Each Authorized User is responsible for insuring that the necessary signs, symbols, and labels are posted and kept in good repair.

### 5.1 Radiation Room Postings

The following signage and postings are required for rooms using radioactive materials:

**Laboratories:** All laboratories operating with more than exempt amounts of radioactive materials, shall be clearly posted with a standard radiation symbol and the words **CAUTION - RADIOACTIVE MATERIALS**.

**Storage Areas:** Each room where licensed radioactive materials are stored shall be posted with the standard radiation symbol and the words **CAUTION - RADIOACTIVE MATERIALS**.

**Radiation Area:** Any area, accessible to individuals, in which radiation levels could result in an individual receiving a dose in excess of 5 mrem in one hour at thirty centimeters from the source of radiation or from any surface that the radiation penetrates.

Each such area is to be clearly posted with the standard radiation symbol and the words **CAUTION - RADIATION AREA**.

**Airborne Radioactivity Area:** Any room, enclosure, or operating area in which radioactive materials exist in concentrations in excess of the derived air concentration (DAC), specified in WAC 246-221-290, or any room, enclosure, or operating area in which airborne radioactive material exists in concentrations where individuals in the area would exceed 0.6% of the annual limit on intake in a week or twelve DAC hours, is defined as an Airborne Radioactivity Area.

Any area which falls within the scope of this definition shall be clearly labeled with a standard radiation symbol and the words **CAUTION - AIRBORNE RADIOACTIVITY AREA**.

Each room and area will have a copy of RHF -3, Notice to Employees displayed.

Each laboratory where radioactive materials are used will have a copy of the Radiation Safety - Laboratory Rules and Procedures posted.

Areas or rooms that fall within more than one of the above requirements will comply with all applicable requirements.

### 5.2 Radiation Room Information

A copy of this document, *WWU Radiation Safety Manual*, is kept readily available in each laboratory to insure that the section containing the emergency procedures is available if needed.

The following information is made available to each laboratory as appropriate:

- A copy of any operating procedures or instructions developed by the AUR or required by the RSO,
- Any notice of violation involving radiological working conditions, proposed imposition of civil penalty, or any order issued by DOH under WAC 246,
- Any response from WWU back to DOH.

Copies of WWU's license application and the license received from DOH are on file with the RSO and are made available as necessary.

### **5.3 Hallway Postings**

All hallway doors leading into rooms or leading to doors of rooms in which radioactive materials are used or stored are posted with the radiation symbol and the appropriate caution phrases described in Section 5.1.

### **5.4 Container Labels**

Each container in which radioactive material is used, stored, or transported shall be labeled with the standard radiation symbol, the words CAUTION - RADIOACTIVE MATERIALS, and the radionuclide, quantity, and date of measurement.

WWU labels for radioactive waste containers are described in Section 7.

### **5.5 Radiation Generating Machine Labels**

All radiation generating machines are labeled in a conspicuous manner so as to caution individuals that radiation is produced when the machine is being operated.

## 6.0 Work Practices in Radioactive Material Laboratories

### 6.1 General Work Practices

Work with radioactive material presents some level of risk. Each radionuclide has different decay characteristics. The chemical and physical form must also be considered. The amount of material or activity and the conditions of use, such as containment and shielding, affect the level of risk.

It is impossible to set work practices that are applicable in all cases. The general work practices which follow in Table 6.B. Radiation Safety - Laboratory Rules and Procedures should be considered as recommendations. This attachment is to be posted in each area where radioactive material is used and laboratory personnel must evaluate their laboratory situation to establish which apply to their work and if there are other specific safe handling practices unique to their work.

In general, compounds labeled with weak beta emitters, (e.g. H-3, C-14, S-35), may be handled safely in the quantities found in most research and teaching laboratories, with only modest precautions. In fact, most of the precautions necessary when handling small quantities are the same as good hygienic laboratory practices. This does not mean that these materials may be treated casually. Users of even small quantities of radioactivity may find experimental work ruined by carelessness.

<b>Table 6.A Survey Equipment and Shielding for WWU Radionuclides</b>				
<b>Radio-nuclide</b>	<b>Radiation/energy</b>	<b>Survey instrument</b>	<b>Shielding</b>	<b>Hazard</b>
H-3	Beta/ 0.019 Mev Low energy	LSC	None needed	Internal exposure
C-14	Beta/ 0.156 Mev Low energy	LSC	None needed	Internal exposure
P-32	Beta/ 1.709 Mev High energy	GM	Plexiglas, Thick plastic	Internal; External to skin and lens of eye
S-35	Beta/ 0.167 Mev Low energy	LSC	None needed	Internal exposure
Nickel 63 Sealed Source	Beta/ 0.066 Mev Low energy	LSC	None needed	Internal exposure only if the source is leaking
Co-57 Sealed Source	Gamma/ 0.122 and 0.137 Mev	NaI best GM ok	Lead	External exposure

Am-241 Foil Source	Alpha/5 Mev Gamma/ 0.06 Mev	GM for gamma	Alpha- none Gamma- lead	Internal exposure only if the source is leaking
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When handling more energetic or "hard" beta emitters, such as P-32, or gamma emitters, further precautions are necessary as shown in Table 6.B.

Geiger Mueller Detector (GM)  
Liquid Scintillation Counter (LSC)  
Sodium iodide crystal scintillation detector (NaI)

## 6.2 Hazard Estimation

Before radiation work begins, estimate the hazards during various phases of each research protocol. Measure or calculate the dose for the expected work. Consider whether shielding is necessary. Determine possible release mechanisms and evaluate potential uptakes for the radionuclides to be used. Compare to the Annual Limits on Intake found in WAC 246-221-290. Determine what controls are needed to assure doses to workers are kept as low as reasonable achievable. Evaluate whether aerosols or vapors are produced. Determine if the work is best done in a chemical fume hood.

## 6.3 Contingency Planning

When working with radioactive materials, it is most prudent to plan for emergencies. This includes making preparations to control spilled materials.

Informing others in the laboratory about the contingency planning gives them the ability to provide assistance following an accident or incident.

It is important to recognize that fire and police responding personnel may be reluctant to enter a room if "radiation" is present unless they have clarity about the form, amount and hazard.

Informing neighboring laboratory personnel about the hazards or lack of hazard is useful and considerate. Estimate the activity and activity concentrations during various phases of the program.

Hazardous situations that develop with radioactive material are seldom obvious. For this reason, implementation of a monitoring and survey program is mandatory for use of radioactive materials.

Establish a schedule for instrument surveys and wipe tests. Record the survey results so that changes and trends are apparent.

## 6.4 Personnel Contamination Precautions

The control of personal contamination is the main way that personnel working with radioactive materials control exposure and internal uptake of radionuclides.

### Personal Protective Equipment

The use of personal protective equipment is essential to protect researchers from exposure when working with dispersible radioactive materials. In Section 5 of the *WWU Safety Information Book*, found in each department's office, the personal protective equipment to be used for each type of hazardous task is listed.

Personal protective equipment generally used with dispersible radioactive materials includes:

- Disposable nitrile gloves
- Laboratory coat
- Safety glasses or goggles when working with liquids or P-32

Wear gloves when handling radionuclides. Gloves serve two purposes; they reduce skin contamination and absorption through the skin, and they provide a clean hand when they are removed or changed so contamination is not spread to a non-radioactive operation, e.g., taking notes or answering the telephone.

It is better to use inexpensive disposable gloves and change them frequently than to "live in" better quality gloves.

In the remote event that re-usable rather than disposable gloves are chosen, gloves may be reused, but do not turn them inside out by inflating the glove to snap out the fingers.

Note that disposable latex gloves are generally considered inappropriate for chemical handling. In most laboratory settings, a better disposable glove is nitrile.

In some cases, a double-layer of gloves may be worn so the outer layer can be changed while the inner layer provides additional protection.

A laboratory coat or apron should be worn while conducting laboratory work with radioactive materials. Sleeves should be tight or banded to keep them out of the way. Lab apparel should be changed every few days and should not be worn out of the laboratory area, especially not into eating areas.

Safety glasses or safety goggles are worn when there is danger of splashing chemicals into the eyes or when working with P-32 due to its high energy beta radiation that can expose the lens of the eyes.

### **Personal Protective Practices**

The wearing of protective equipment is one of the most important personal protective practices that are employed to minimize personal contamination and exposure to radionuclides. Other practices include:

Wash hands thoroughly after work with radionuclides, and then monitor the hands. Soap and water are normally sufficient for cleaning but could use standard commercial cleaning agents if necessary.

Eating, drinking, and chewing gum in radioactive materials laboratories is forbidden. Food or drink is neither stored (including in refrigerators) nor prepared in radioactive materials laboratories.

Remove laboratory coats and wash hands before eating, drinking or using the rest room.

Mouth pipetting of any material is forbidden in radioactive material laboratories. This includes mouth pipetting of innocuous materials, as the pipette may be contaminated. Also included is the use of mouth tubes for micro-pipetting; these devices are easily contaminated when dropped in a pocket or set down on the work bench.

Any procedure or habit that includes placing anything in the mouth while working in a radioactive materials laboratory is strongly discouraged. This includes chewing pencils, biting nails, wetting fingers to turn pages, holding eye glasses in one's mouth, licking gum labels, using a toothpick, etc.

Smoking is not permitted within any WWU building.

## **6.5 Instrument Surveys**

In laboratories where high energy, penetrating radiation is present, portable radiation survey instruments are used (See Table 6.A). Survey instruments are calibrated annually to ensure that readings are accurate.

Survey laboratory work areas for contamination after each procedure, or at the end of the day. Decontaminate areas as necessary. Refer to Section 11 for information.

Use survey instruments as follows:

**During procedures** when stock radionuclides and other concentrated forms of radioactivity are in use, carefully monitor hands, wrists, and garment fronts. Frequent monitoring is necessary to allow prompt detection of contamination, to determine the source, and to institute controls.

**Following each use** of radionuclides, monitor the bench top, adjacent floor area, and associated equipment. Document this survey in written form as described in Section 11.

**Before leaving the laboratory**, monitor hands and clothing, including shoes.

## **6.6 Wipe Tests**

Surface contamination can be evaluated by wiping suspect areas and analyzing the wipes with an appropriate counter. Wipe tests assayed by liquid scintillation counter, are required in areas where H-3, C-14, and S-35 are used.

Wipe tests are also essential for work with other radionuclides when the ambient radiation level is high due to the procedures in progress. For example, the high background from material within a flask will not allow detection of material spilled on the outside of the flask.

Wipes should be taken from bench tops, knobs, handles, floors, and inside equipment storage areas. Wipe tests can be analyzed in several highly sensitive instruments such as internal proportional counters or liquid scintillation counters.

The wipe test is employed as a very sensitive method for detecting contamination. Establish a schedule for wipe surveys. Vary the location and pattern of the survey points. When wiping near "hot" work, where contamination is expected, use extra care to avoid contaminating hands and thereby cross-contaminating subsequent wipes. Also wipe in the same area each time to note gradual build-up of contamination levels. Both procedures should be used.

Wipe tests should be conducted after each experiment. Wipe tests shall be conducted at least weekly when the laboratory is used for radiation work.

## **Table 6.B.**

### **Radiation Safety - Laboratory Rules and Procedures**

*Post These Rules In Each Laboratory Or Storage Room where Radioactive Material Is Used Or Stored.*

1. Wear laboratory coats or other protective clothing at all times in areas where dispersible radioactive materials are used.
2. Wear disposable gloves at all times while handling dispersible radioactive materials.
3. Monitor hands and clothing for contamination after each procedure or before leaving the area.
4. Use shielding devices and/or remote tools when working with millicuries quantities of radioactive materials such as P-32 that emits high energy beta radiation or sealed sources that emit gamma radiation.
- 5.A. Do not eat, drink, smoke, or apply cosmetics in any area where radioactive material is stored or used.
- 5.B. Do not store food, drink, or personal effects with radioactive material (e.g., in refrigerator).
6. Wear personnel monitoring devices (film badge or TLD) if required at all times while in areas where radioactive materials are used or stored. These devices should be worn at chest or waist level. Personnel monitoring devices when not being worn to monitor occupational exposures should be stored in a designated low background area.
7. Wear TLD finger badges when manipulating millicuries quantities of radioactive materials.
8. Dispose of radioactive waste only in specially designated drains or shielded, labeled solid or liquid waste receptacles. Never in ordinary trash.
9. Never pipette by mouth.
10. Survey laboratory work area for contamination after each procedure, or at the end of the day. Decontaminate if necessary.
11. Confine radioactive solutions in covered containers plainly identified and labeled with name of compound, radionuclide, date, activity, and radiation level, if applicable.
12. Always transport radioactive material in shielded containers.
13. Use remote tools when handling sealed sources.
14. Keep all radioactive liquids in secondary containment.
15. Use the minimum quantity of radioactive material needed. Always work over a suitable spill tray lined with an absorbent disposable pad. Use a hood for dispersible/ volatile materials.
16. Keep radiation exposure rates to personnel as low as possible. Use appropriate shielding and remote handling devices, as described above.
17. Maintain a high standard of cleanliness and good housekeeping must be maintained in all laboratories where radioactive material is present.
18. Consider using one or more preliminary "dry runs" with appropriate materials for new procedures and new personnel to test the effectiveness of the procedures and equipment.
19. Report all open injuries involving radioactive material to the Radiation Safety Officer who monitors if the wound is contaminated.
20. Safety training is required for all persons using radioactive materials.
21. Store radioactive material in a secure fashion to prevent unauthorized removal or use.
22. Authorized users are responsible for the monitoring and for the cleaning of their laboratories. Custodial personnel shall not handle any radioactivity.
23. Authorized Users must maintain complete records of receipts, transfers, waste accumulation, surveys, and disposal of radioactive materials.

## Radiation Safety - Laboratory Rules and Procedures - Continued

24. Call the Radiation Safety Officer prior to disposal of radioactive gas waste through the hood.
25. Decontamination.
  - a. Skin should be thoroughly washed and surveyed with a survey meter to ensure measured radiation is at background levels.
  - b. Work surfaces should be cleaned so that they show no levels of contamination above background, if possible.
26. All spills of radioactive materials must be reported to the Radiation Safety Officer. In the event of a spill:
  - a. Blot up any liquid immediately.
  - b. Attempt to prevent the spread of the spill.
  - c. Isolate the spill area, mark it, define the nature of the contaminant and restrict access to the area.
  - d. A radiation survey of the area and personnel present should be made immediately.

## Back of Section 6

## 7.0 Radioactive Waste Disposal

In accordance with University Policy [U5950.01](#) regarding Health, Safety and Environmental Protection, all University personnel are to dispose of radioactive wastes in a manner which will not create a hazard to human health or the environment.

Although it is difficult to establish a method for full accountability, proper waste packaging and labeling remains on the honor system, with voluntary compliance. The Authorized User ensures proper packaging and handling of waste generated within her or his operation. Improperly packaged waste could become an exposure hazard to those around it during subsequent handling and transportation. Any improperly packaged waste must be repackaged to comply with shipping regulations.

All radioactive wastes are collected for disposal by the Radiation Safety Office. **Wastes from different RAM shipments are not combined.** For collection of radioactive waste, complete Form 1.I provided in Appendix 1. Disposal to the sanitary sewer is only authorized with direct permission of the Radiation Safety Officer into specially designated drains. Authorized Users must maintain a log of sewer disposal (See Appendix 1 Form 1.k). The RSO will assure that the amount of H-3, C-14, and P-32 disposed to the sewer does not exceed 10 millicuries per month for each radionuclide so that the limits in WAC 246-221-290 Appendix A Table 3 will not be exceeded. See Section 7.8.1 for details on sewage disposal.

### 7.1 Long Half-life Material (e.g. H-3 and C-14)

Solid and some liquid radioactive waste materials with long half-lives are held for pickup by the Radiation Safety Officer for commercial waste disposal as necessary. The Authorized User assigns a person in the laboratory to schedule each pickup of waste with the RSO and/or the Environmental Health and Safety Office.

The radioactive waste materials containers are packaged securely and labeled with the following information:

- The words "radioactive material"
- The WWU Radioactive Materials (RAM) number/s, (i.e. the unique identification code assigned to incoming shipment of material).
- The date the original shipment was received.
- The date the waste package/container was sealed.
- The estimated activity of the packaged waste.
- The name of the isotope.

Upon verbal authorization of the Radiation Safety Officer, aqueous liquid waste with long half-lives is disposed via the sanitary sewer in accordance with WAC 246-221-190. (See 7.8.1)

### 7.2 Short Half-life Material (e.g. P-32 and S-35)

Solid and liquid radioactive waste with short half-lives are held for pickup by the Radiation Safety Officer. The Authorized User assigns a person in the laboratory to schedule each pickup of waste with the Radiation Safety Officer and/or the Environmental Health and Safety Office.

**Wastes from different RAM shipments are not combined.** The radioactive waste containers are packaged securely and labeled with the following information:

- The words "radioactive material"
- The WWU Radioactive Materials (RAM) number/s, (i.e. the unique identification code assigned to incoming shipment of material).

- The date the original shipment was received.
- The date the waste package/container was sealed.
- The name of the radionuclide.

Once picked up, this material is stored in an authorized area provided by WWU under the direction of the Radiation Safety Officer. It is a secure area, listed on License, and open only to authorized personnel.

The RSO ensures short half-life radionuclides are held until their radioactivity is indistinguishable from background. This is normally 10 half-lives. After this time period, the RSO or designee surveys the waste with an instrument suitable for detecting the radiation emitted by S-35 or P-32. The survey is documented using Form 1.a. Radiation Survey Record. If no radiation levels are detected above background then all radioactive labels are removed or defaced, and waste is disposed as non-radioactive waste. Any waste which is still radioactive will be disposed as radioactive waste. Aqueous liquid waste that has not reached background is disposed via sanitary sewer in accordance with WAC 246-221-190 (See 7.8.1).

### 7.2.1 Cobalt-57 Sealed Sources

Cobalt-57 has a half-life of 270 days which is longer than the standard 120 days used for decay-in-storage prior to disposal. In accordance with the WWU license, these sources may be held for more than ten half-lives until activity is indistinguishable from background when surveyed with an appropriate instrument. Sources will then be disposed as non-radioactive waste in normal trash. Leak tests and/or inventories shall be performed on the stored sources as required in WAC 246-221-080. Alternatively, the sources may be added to a routine radioactive waste shipment prior to the activity being indistinguishable from background.

## 7.3 Liquid Scintillation Cocktail Waste

WWU only allows use of liquid scintillation cocktail that is approved by the Washington State Department of Ecology for disposal into the sanitary sewer and that is not designated as hazardous or dangerous material so no mixed waste is created. There are currently three approved cocktails: (1) Ecoscint Original - National Diagnostics; (2) Opti-Fluor – Perkin Elmer Life and Analytical Sciences; and (3) Microscint-O – Perkin Elmer Life and Analytical Sciences . The RSO verifies that other scintillation cocktails are acceptable for use on an individual basis. Spent cocktail from liquid scintillation vials is collected in 1 gallon polyethylene containers. The vials are rinsed once with water and that rinse is collected as radioactive waste in the same container as the original sample of cocktail.

Additional rinses of the vials may be discarded in the sanitary sewer. The vials may then be disposed as normal waste or cleaned and reused. The collected bulk cocktail waste is labeled with the following:

- a. The identity of the isotope counted and the RAM # associated with it.
- b. The total activity of the material in the container.
- c. The brand name of the cocktail used.
- d. "Caution-Radioactive Material".

The collected bulk liquid scintillation cocktail and rinse is picked up by the Radiation Safety Officer. The waste is disposed by the Radiation Safety Office in accordance with applicable state and federal laws governing the handling of said materials.

Upon verbal authorization of the Radiation Safety Officer, liquid scintillation waste with a long half-life is disposed via the sanitary sewer by the user in accordance with WAC 246-221-190. Depending

on work load, vials may or may not be rinsed. If they are not rinsed they will be placed in the solid radioactive waste.

Vials that contain wipe samples less than 3 times background may be treated as non-radioactive. Scintillation fluid may be put to the sanitary sewer. Following two rinses which are put to the sanitary sewer, vials and wipes may be placed in the ordinary trash.

#### **7.4 Waste Packaging**

Solid radioactive waste is packed into two heavy duty polyethylene trash bags. If the material is being held-for-decay, radioactive marking should be removed or defaced before items are placed in the solid waste. Liquid waste is collected in one-gallon high density polyethylene containers, generally provided by the Radiation Safety Office. All containers are well sealed, free from spillage and labeled in accordance with this manual. Radioactive waste labels may be requested from the RSO or other staff in the Environmental Health and Safety office.

#### **7.5 Inappropriate Disposal Methods**

Direct release of radioactive materials by staff, other than radiation safety personnel, is not an acceptable means of disposal. Release may only occur with direct authorization from the Radiation Safety Officer.

Incineration is not an authorized method of disposal of WWU's radioactive waste.

#### **7.6 Waste Records and Labeling**

WWU's License and state regulations require that inventory and control methods cover all aspects of work with radioactive materials. Therefore, all packages and containers of radioactive waste must be labeled with a standard radiation symbol, the words "**CAUTION - RADIOACTIVE MATERIALS**", and a description of the contents.

**The label must indicate the radionuclide, the activity in microcuries or millicuries, the name of the Authorized User, the date the shipment was received, the date the package was sealed and the WWU RAM# associated with the original shipment of material.**

Tags or labels with the aforementioned information must be attached to each container. Containers are to be securely closed and free from defect. Request waste labels from the Environmental Health and Safety office.

#### **7.7 Keeping Radioactive Waste From Normal Waste Streams**

It is especially important to avoid inadvertent collection of radioactive waste by University custodians. A label with a radiation symbol should be temporarily attached to open containers in the laboratory when other labels are not apparent.

#### **7.8 Additional Waste Information**

It is not necessary to use the full capacity of a container before it is sealed for collection. The waste from a "hot run" should be sealed away and removed rather than keeping it in the lab until the container is full.

Vapor and fumes may accumulate above waste containers. Waste collection of volatile materials should be maintained in or near a fume hood or other well-ventilated space.

Culture medium and other liquid waste may continue to be biologically active. This could build up pressure in a sealed can and cause rupture. An appropriate chemical to stop growth, such as bleach to a culture media, should be added to any such waste, upon consultation with the Radiation Safety Officer.

Radioactive liquid which is otherwise quite hazardous, (e.g., strong acids, bases, flammable liquids or highly toxic substances) are handled with proper attention to all hazards present. All hazards contained within a waste are displayed on labels and on waste disposal forms. If special containers

or handling are necessary, arrangements should be made with the Radiation Safety Officer before generating the waste.

The volume of radioactive waste should be kept to a minimum. Avoid the use of radioactive waste containers for non-radioactive waste because disposal is expensive.

### **7.8.1 Disposal of H-3, C-14, and P-32 to Sanitary Sewer**

Radioactive material may be disposed to the sewer in accordance with WAC 246-221-290 Appendix A Table 3. A calculation was done of the typical monthly amounts that might be disposed compared to the sewage flow rate at the facility. The concentration was found to be far less than the concentration values in Table 3. As long as the yearly disposal of H-3, C-14, and P-32 does not exceed 10 millicuries per month for each radionuclide the regulatory limits will not be exceeded. Ten millicuries per month is far greater than the expected sewer disposal.

Sewer disposal must meet the following requirements:

- All aqueous waste must be readily soluble or it must be biological material that is readily dispersible in water.
- Aqueous waste must not contain any other chemicals at concentrations that are inappropriate for such disposal and may never include dangerous waste.
- A log must be kept of all H-3, C-14, P-32 put to the drain. (See Appendix 1 Form 1.k); logs are sent annually to the RSO)
- Drain disposal is performed under the direction and auspices of an AUR

#### **7.8.1.1 Disposal of C-14 to Sanitary Drain at Shannon Point Marine Center**

Specifically, in 2005, the disposal of C-14 to the sanitary drain at Shannon Point Marine Center was approved by the WA State Department of Ecology, WA State Department of Health and the City of Anacortes, with specific requirements in addition to those above:

- The total waste disposed to the sewer must be less than 5 microCuries per year, less than 0.416667 microcuries per month.
- All aqueous waste must be low in C-14 concentration, must not contain other chemicals inappropriate for drain disposal, and must be put to the drain in small amounts containing small amounts of radioactivity. No dangerous waste may go down the drain.
- A log must be kept of all C-14 put to the drain. (Form is at the end of this document; logs are sent annually to the Radiation Safety Officer)
- All waste must be put to the drain in Room 204, which is approved for use of radioactive materials.
- Following drain disposal, cold water is to be run in the sink for a minimum of 15 minutes.

- Prior to any drain disposal, contact Shannon Point's Facility Maintenance Mechanic to coordinate. If s/he is not available, postpone disposal until s/he is reached or mutually agreeable arrangements are made.
- Drain disposal is performed under the direction and auspices of a Shannon Point Marine Center Authorized User of Radioactive material.

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## 8.0 Limits of Exposure to Ionizing Radiation

Every reasonable effort is made at the University to maintain radiation exposures as low as reasonably achievable (ALARA).

In accordance with WAC 246-221-010, annual adult exposures are controlled to the more limiting of the following:

- A total effective dose of 5 REM
- The sum of the deep dose equivalent and the committed dose equivalent to any organ or tissue, (excluding the eye), of 50 REM and
- Annual limits to the lens of the eye, skin and extremities which are:
  - An eye dose equivalent of 15 REM
  - A skin or extremity dose equivalent of 50 REM

Persons under 18 years of age are limited to 10% of the adult occupational limits.

### 8.1 Pregnant Women

If you are a radiation worker and are pregnant, you have the option of declaring your pregnancy in writing to the Radiation Safety Office and taking advantage of voluntary limits for dose to the embryo/fetus. (Refer to Appendix 1 for form). The occupational dose limit to the embryo/fetus of a declared pregnant woman is 0.5 rem for the entire gestation period in accordance with WAC 246-221-055. Once pregnancy is declared every effort shall be made to assure radiation exposure is received at a uniform rate per month in order to satisfy the limit to the embryo/fetus. Women, whether employees of the University or students, are to restrict their radiation exposures to meet the established limit for the embryo/fetus. Guidelines and information is found in Nuclear Regulatory Commission's (NRC) Guide 8.13, *Instructions Concerning Prenatal Radiation Exposure*, and the Appendix to the Guide, *Possible Health Risks to Children of Women Who Are Exposed to Radiation During Pregnancy*.

Written acknowledgement from all females who wish to work with or near radioactive materials or radiation-producing equipment is required prior to being allowed to work with ionizing radiation. The acknowledgement states that a woman has read and understands the contents of the NRC Guide and Appendix (Refer to Appendix 1 for form).

The Radiation Safety Officer maintains a file of written acknowledgements and declarations of pregnancy for a period of 30 years.

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## 9.0 Personnel Monitoring

Personnel monitoring is an essential element of any radiation safety program and is required by WAC 246-221-090 for external dose and WAC 246-221-100 for internal dose.

### External Dose

Monitoring with personnel dosimeters is required for:

- Adults likely to receive, in one year from sources external to the body, a dose in excess of 10% of the annual limits described in Section 8.
- Minors likely to receive in one year from sources external to the body, a dose in excess of 10% of the annual limits described in Section 8.
- Declared pregnant women likely to receive during the entire pregnancy, from radiation sources external to the body, a deep dose equivalent in excess of 1 mSv (0.1 rem). All of the occupational dose limits specified in WAC [246-221-010](#) continue to be applicable to the declared pregnant worker as long as the embryo/fetus dose limit is not exceeded.
- Each individual who enters a high radiation area – defined as an accessible area in which radiation levels from sources external to the body could result in an individual receiving a dose in excess of 0.1 rem in one hour. (See WAC 246-220-010 for a complete definition.)

Monitoring is occasionally used for persons who have expressed a special concern for their exposure to radiation even though the possibility of receiving a significant dose is very low. This applies to persons who have relatively little contact with radiation but are nevertheless concerned about their exposure. In many instances such monitoring will provide an assurance they are working at "background" levels. Monitoring devices are issued at the discretion of the Radiation Safety Officer. A primary consideration will be the legitimate concern expressed by the individual.

Personnel dosimeters are provided by WWU through the Radiation Safety Office, to persons who are qualified under one of the above reasons. The Radiation Safety Officer maintains all personnel monitoring records as required by regulations.

Individuals are informed of their exposure at any time upon request and receive an annual summary of their records from the past year.

Individuals are notified immediately of any exposure of more than 20 millirem per quarter. In order not to establish a false sense of protection, personnel dosimeters are not issued to persons using low energy beta emitters, (e.g. H-3, C-14 and S-35) because dosimeters do not measure low energy beta radiation.

The RSO supervises the acquisition, distribution, and collection of personnel dosimeters. Personnel dosimeters are changed on a quarterly basis.

If an exposure in excess of the limits is suspected, the RSO is notified immediately so that the dosimeter may be processed for rapid analysis.

It is the responsibility of the AUR to notify the RSO in a timely manner whenever an individual requires personnel monitoring and whenever the need for personnel monitoring is terminated.

When not in use, personnel dosimeters are stored in areas where they will not be exposed to ionizing radiation other than background radiation. At no time is a personnel dosimeter deliberately exposed to radiation.

Persons who are using dosimeters should report any diagnostic or radiotherapeutic procedures using radionuclides or devices (x-rays, linear accelerators) to the RSO. Dosimeters are never worn during these procedures or any medical or dental x-ray exposures because the occupational limits apply only to occupational exposure.

## **Internal Dose**

Personnel internal monitoring is required for:

- Adults likely to receive, in one year, an internal dose (intake) in excess of 10% of the applicable Annual Limit on Intake (ALI).
- Minors likely to receive, in one year, a committed effective dose equivalent in excess of 10% of 0.05 rem.
- Declared pregnant women likely to receive, during the entire pregnancy, a committed effective dose equivalent in excess of 0.1 rem.

The most common method for determining internal exposure in a university setting is by doing bioassays. See Section 10 for a description of the bioassay procedure. For the current approved uses under WWU's license WN-C007-1, no bioassays are required.

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## 10.0 Bioassay Requirements

Bioassays are a necessary complement to personnel monitoring in a radiation safety program when the types and quantities of radionuclides used require it. It is the principle method for estimating an individual's exposure to radiation resulting from internally deposited radionuclides.

The risk of working with H-3 and C-14 results from possible internal dose that occurs when either radionuclide is incorporated into the body. H-3 is usually incorporated as tritiated water and C-14 in the form of CO<sub>2</sub> gas.

There is generally no external radiation hazard from these radionuclides since their low energy beta particles will not penetrate skin. The low energies also make H-3 and C-14 exceedingly difficult or impossible to detect with portable survey monitors.

Exposure to H-3 and C-14 is best evaluated by the direct method of analyzing body water for either radionuclide. This is done by assaying a few milliliters of urine by liquid scintillation counting.

Bioassays are required for any person using open sources of more than 100 millicuries of H-3 or C-14 or working in a laboratory where more than 100 millicuries of H-3 or C-14 is stored during any calendar year. Guidance for H-3 bioassay programs can be found in NRC Regulatory Guide 8.32 Criteria for Establishing a Tritium Bioassay Program

The results of bioassays and an interpretation shall be provided to the individual and maintained in a file for the individual in the Radiation Safety Office.

While use at WWU is unlikely to require bioassays, if they become necessary due to a change in use or an incident, the RSO will find a qualified vendor to meet the need. Below is a link to a webpage listing health physics providers in Washington State.

<http://www.doh.wa.gov/CommunityandEnvironment/Radiation/RadioactiveMaterials/TechnicalAssistanceProviders.aspx>

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# 11.0 Monitoring and Surveys

Radiation hazards cannot be evaluated without measurements. Periodic monitoring and surveying of radiation facilities are essential to a proper radiation safety program. Radiation surveys are required where radioactive material is used or stored and where radiation generating equipment is used

Each AUR of radioactive material is required to conduct surveys within his or her own areas. Radioactive materials laboratories may also be inspected and surveyed by the Radiation Safety Office every six months or more often if the RSO deems more frequent surveys advisable. The RSO may conduct audits as well to assure that Authorized Users are conducting their surveys as required.

It is essential that surveys are documented in the AUR's laboratory operating record and that permanent records of survey results are maintained and copies are sent to the Radiation Safety Office. The documentation must include the information in 11.1 Item 5.

## 11.1 Standard Survey Program for Unsealed Radioactive Material

The standard survey is outlined below. Depending on the radionuclide used, the steps are different as shown:

- **P-32 (high energy beta emitter)** - Steps 1-6 below
  - **H-3, C-14, and S-35 (low energy beta emitters)** - Steps 2, 3, 4.B, 5, 6 below
  - **Sealed Sources (Gamma emitters).** Refer to Section 11.4.
1. A reference check source of long half-life, e.g., Cs-137 or Ra-226, is utilized and the results recorded at the time of the initial receipt of the instrument or as soon as the instrument is received from calibration. The readings shall be taken with the check source placed in specific geometry relative to the detector. A reading of this reference check source shall be taken before each survey, and after maintenance and/or battery change. If any reading using the same geometry is not within  $\pm 20$  percent of the reading measured immediately after calibration, the instrument must be re-calibrated.
  2. A documented survey shall be performed in all use areas on a weekly basis unless they meet one of the criteria below. If they meet one of these criteria they may be surveyed monthly.
    - A. A room, such as counting, equipment, or autoradiograph room, where all material is contained and unopened.
    - B. Waste storage areas which are accessed infrequently e.g. once a month or less.
  3. Daily or after use, surveys will be done of clothing, hands, feet, and work areas when working with any radionuclide, using an appropriate low range instrument or by taking wipes which are counted in a Liquid Scintillation Counter (LSC). After-use surveys will be done if a spill is suspected for all radionuclides. Documentation of these surveys is not required, unless contamination is found to be present at levels more than three times background on a hand held instrument, or 1000 dpm per 100 cm<sup>2</sup> for beta or gamma or 20 dpm per 100 cm<sup>2</sup> for alpha on LSC or other precision counting instrument.
  4. All surveys will consist of:
    - A. A direct measurement of radiation levels or contamination levels with an appropriate survey meter sufficiently sensitive to the radionuclides used in the area. This measurement is not required or feasible for low energy beta emitters such as H-3, C-14, or S-35.

- B. A series of wipe tests to measure removable contamination level. The method for analyzing wipe tests must be sufficiently sensitive to detect 1000 dpm per 100 cm<sup>2</sup> for beta or gamma, or 20 dpm per 100 cm<sup>2</sup> for alpha. If you are using a portable instrument to measure the wipes, go to a low background area to count the wipes. Liquid scintillation counting or an approved sufficiently sensitive detection instrument shall be used for H-3, C-14, and S-35.
5. For all required documented surveys, a permanent record will be kept of all survey results, including negative results. The records shall include:
    - A. Location, date, and person doing the survey.
    - B. Identification of equipment used, including serial number and pertinent counting efficiencies.
    - C. Drawing of the area surveyed, identifying relevant features such as storage areas, waste areas and major use areas. Also include numbered locations corresponding to the places surveyed.
    - D. Measured exposure or count rates, keyed to locations on the drawing.
    - E. Results of surveys for removable contamination, keyed to locations on the drawing.
    - F. A background reading for the portable instrument and the results of a blank wipe for non-portable counters.
    - G. Corrective action taken when survey results exceed action levels.
  6. Action level for direct survey and contamination surveys will be three times the background reading in an area with no radioactive material present or three times the reading on the blank wipe. The Acceptable Surface Contamination Levels designated in WAC 246-232-140 Schedule D may also be used.

## 11.2 General Information and Guidance on Laboratory Monitoring

The safe use of radioactive material requires frequent monitoring and surveys in each area where unwanted contamination or external radiation may exist. In laboratories where handling practices are good, the results of the survey are usually negative. It is difficult to define a "safe" or level of unwanted contamination or external radiation. The important word is "unwanted." If radiation is unwanted, it should be removed if possible. Three times background should be considered "real" contamination.

Unwanted contamination or external radiation may interfere with experimental sensitivity and results. This effect is often far more limiting than what might be defined as safe for personnel. Concern may develop from a neighbor who is working at a lower level of sensitivity. This is another reason laboratory monitoring should be an integral part of the laboratory protocol.

As described above, laboratory monitoring is conducted during radioactive materials work. In addition, a thorough survey of work space and adjacent fringe areas is conducted after cleanup and at the end of the work period.

Laboratory monitoring includes two complementary techniques:

- **Instrument Surveys:** A portable instrument, normally a Geiger Muller (GM) counter is used to scan work surfaces, handles, knobs, floors, sinks, waste receptacles, etc. High readings are noted and explained when working with P-32 or gamma emitters.

The instrument survey is necessary to evaluate shielding, accumulation of high levels from waste containers and general external radiation levels. Some types of radiation, especially low energy emissions, are not effectively detected with standard survey instruments. G-M type counters are not effective for H-3, C-14 and S-35. An LSC must be used. The sensitivity and calibration of any instrument is to be established for the expected radiation.

**Wipe Surveys.** The greater hazard in most radioactive materials laboratories is from ingestion or inhalation of material and the resulting internal dose. A small amount of radioactive material, if fixed on a work surface, is relatively safe. The same amount of material may constitute a hazard if it is ingested. The main method for evaluating transferable material

is to take a series of wipes from surfaces with small filter paper disks, and then evaluate the wipes with an appropriate detector.

A sketch of the floor plan of the work area is used when making wipe tests. A number corresponding to each wipe, correlating it with the location from which it was taken, is included on the sketch. This allows an easy mapping and evaluation of contaminated areas and may aid in locating the source of the contamination.

In addition to the regularly surveyed spots, random areas should be checked because contamination may or may not be uniform throughout the room. Wipe surveys are sensitive, but the results of a wipe survey are considered only slightly better than qualitative. The results from a wipe survey help establish if radioactive material is contained.

If radioactive material has spread beyond the control area, the AUR is notified and joint evaluation of control procedures are implemented. The spread may have extended to an adjacent experiment.

### **11.3 Survey Instrument Requirements**

The AUR ensures that calibrated instruments in good working order are available to allow frequent checks during work and thorough surveys after use of radioactive material.

**Operation of Survey Instruments:** Each instrument used for surveying purposes is to be operability tested with a check source prior to use as described in 11.1 Step1 above .

**Calibration of Survey Instruments:** All survey instruments used for contamination surveys are to be in current calibration when used. The RSO calibrates or obtains calibration services for all WWU survey instruments which require periodic calibration. These instruments are calibrated at least yearly and after any maintenance or repair of the unit.

Other instruments, such as those used for classroom instruction or research, may be calibrated by the Radiation Safety Office at the user's expense.

### **11.4 Sealed Source Leak Tests and Inventories**

All sealed sources, other than H-3, with a radioactive half-life greater than thirty days and not in the form of a gas, are tested for leakage at intervals not to exceed 6 months. They must also be inventoried every 6 months which is generally done simultaneously with the leak tests.

No leak test is required when the source contains H-3 or 100 microcuries or less of beta/gamma emitting material or 10 microcuries or less of alpha emitting material.

- Licensed sealed sources must be leak-tested at least every 6 months. At WWU, leak test kits provided by a vendor are used. Swabs of the sources are mailed to the vendor for evaluation. Resulting reports are maintained at the Radiation Safety Office.

### **11.5 X-Ray Facilities**

X-ray facilities at WWU are inspected and/or surveyed by the RSO or designee at least once a year in accordance with WAC 246-228 Radiation Protection-Analytical X-Ray Equipment. The facilities are also surveyed after any maintenance that requires disassembly or removal of a component.

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## 12.0 Disciplinary Procedures

Any Authorized User of radioactive material, who is found to be in violation of federal or state regulations or University directives which, in the opinion of the Radiation Safety Officer, is a major violation, is immediately suspended from operation by the Radiation Safety Officer.

Upon notification of an alleged violation, the following procedure applies;

The Authorized User immediately transfers all radioactive material under his or her responsibility to the Radiation Safety Officer.

The Radiation Safety Officer conducts a comprehensive survey of the laboratory before releasing it for other use at WWU.

The Radiation Safety Officer sends the information to the Dean and the Provost.

If a DOH inspector found evidence of violation of regulations in WAC 246 during an inspection of WWU's facilities, the inspector holds the authority to censure or to revoke an Authorized User's ability to use radioactive materials and may also revoke the WWU License.

### 12.1 Definition of Violations

**Minor Violations:** Violations which are relatively minor, e.g. failure to maintain proper survey records, failure to wear a personal radiation monitoring device in a radiation area at all times, or similar infractions are minor violations.

**Major Violations:** Willful negligence, allowing radioactive material to be lost, using radioactive material in such a way that excessive exposure occurs to one or more persons, deliberate disregard of safety rules, etc., are major violations.

### 12.2 Penalties for Minor Violations

**First minor violation:** a written reprimand from the Radiation Safety Officer detailing the violation with a copy to the department concerned. The reprimand also list the additional levels of discipline possible should further violations occur.

**Second minor violation:** a two-week suspension of the user's authorization. Users may be required to review the radiation safety directive and repeat training. Copies of the disciplinary action are sent to the department concerned, the dean of the user's college, and the Provost/Vice President of Academic Affairs.

**Third minor violation:** a suspension of a period of up to 3 months of the user's authorization. Copies of the disciplinary action are forwarded as specified above.

**Fourth minor violation:** this may result in a permanent suspension of the user's authorization. Copies of the disciplinary action are forwarded as above.

### 12.3 Penalties for Major Violations

Actions taken for a substantiated major violation will, at a minimum, consider a 30-day suspension of the authorization to use radioactive materials, but may be more severe and may include any of the options for disciplinary action authorized by Western Washington University.

Determination of Validity of Violations: The Radiation Safety Officer investigates all reports of violations, which assists in determining the validity of the charge before any disciplinary actions are considered by the Dean and/or Provost

**Appeals:** If a user wishes to appeal an action, he or she has the right to appeal.

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## **13.0 Transportation of Radioactive Materials**

Transportation of radioactive materials on campus is by methods approved by the Radiation Safety Officer. Normally, packages of radioactive material are only transported by University vehicles or by hand.

Packages are positioned in vehicles to prevent falling in case of a sudden stop. They are always transported in double containment vessels to prevent spread of a spill.

Appropriate shielding is always used to keep personnel doses as low as reasonably achievable (ALARA).

Transportation of radioactive materials from the campus is performed under the supervision of the Radiation Safety Officer and in accordance with guidance from the Washington State Department of Transportation.

Transportation of radioactive materials by WWU personnel is performed in accordance with DOH regulations in WAC 246-231-001 and 246-231-030, which outline U.S. Department of Transportation regulations that must be followed.

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## 14.0 Training

All persons who work with radioactive materials and/or radiation-producing equipment at WWU, who enter radiation areas regularly, or who direct the activities of others that work with radioactive materials, must be thoroughly familiar with the safety requirements for handling radioactive materials or using radiation-producing equipment.

Training in the handling of radioactive materials is required for all persons who generate radioactive wastes. The RSO is responsible for either conducting or arranging this training.

The RSO screens the credentials of all persons applying to become Authorized Users. Where additional experience, peculiar to an individual laboratory or experiment is considered essential to the safety of workers in the laboratory, the Radiation Safety Officer may require further training.

All persons who work around ionizing radiation, including AURs, are required by the RSO and the License to complete radiation safety training. All individuals may be required to pass a general written test on the safe handling of radioactive materials. The Radiation Safety Office maintains records of training.

Persons with documented prior training are required to demonstrate their knowledge before beginning work involving radionuclides.

Training for radiation workers requires the following items but is not limited to them:

1. General radioactive materials safety rules.
2. Personnel monitoring program (e.g., use, exchange, storage, records, and reports).
3. Radiation and contamination survey program.
4. Accident, incident and emergency procedures.
5. Applicable state and federal rules and regulations and license conditions.
6. Radioactive materials work procedures:
  - Ordering, receipt and opening procedures;
  - Storage;
  - Use of radioactive materials;
  - Waste packaging and storage;
  - Transportation procedures.

Additional topics for training include:

1. The biological effects of ionizing radiation.
2. Precautions and procedures to minimize exposure, (e.g., time, distance, shielding, protective clothing, etc.).
3. Use and care of survey instruments, including personnel dosimeters.
4. Characteristics of ionizing radiation, natural and human-made.
5. Units of radiation and estimates of dose equivalents, and dose-equivalent limits.
6. Modes of exposure, external and internal.

7. The individual's responsibility to report to the Radiation Safety Officer any conditions which may lead to or cause violation of the State or University regulations or license provision, or any unsafe conditions related to exposure to ionizing radiation.
8. The rights of the worker to be informed of their radiation exposure and bioassay results.
9. The responsibilities of the Radiation Safety Officer and interaction with faculty, staff and students at WWU.

In addition to the training provided by the Radiation Safety Officer, each Authorized User may need to provide additional, detailed training to persons working under his or her authorization, pertaining to the particular experiment or laboratory involved.

The RSO, or designee, will provide instruction to ancillary personnel, such as clerical, janitorial, and security personnel, whose duties may require them to work in the vicinity of radioactive material or near radiation generating machines. The following topics are considered for inclusion, based on the interaction with radioactive materials or radiation, but additional information may be provided:

- A. All terms of the WWU radioactive materials license pertinent to radiation safety.
- B. Identification of areas where radioactive materials are used or stored.
- C. Potential hazards associated with radioactive material.
- D. Radiological safety procedures appropriate to their respective duties.
- E. Pertinent state and federal regulations.
- F. Rules and procedures in the WWU Radioactive Materials License and WAC 246.
- G. Obligation to report unsafe conditions to the Radiation Safety Officer.
- H. Appropriate response to emergencies or unsafe conditions.
- I. Right to be informed of their radiation exposure and bioassay results.
- J. Locations where the University has posted or made available notices, copies of pertinent regulations, and copies of the University's license and license conditions (including applications and applicable correspondence) as required by WAC 246-222.

The RSO verifies that personnel are properly instructed before assuming duties with, or in the vicinity of, radioactive materials or radiation generating equipment, during annual refresher training, and whenever there is a significant change in duties, regulations, or in the terms of the license.

In addition to the training required above, hands-on training is highly recommended in the following areas:

- A description and demonstration of all "hot" procedures by a qualified and experienced staff or faculty member.
- A "cold run" of the procedures by the trainee while being observed by a qualified staff or faculty member.
- Observation of the trainee on at least one run of the full and actual procedure.

Where radioactive materials are used in the classroom as an integral part of a course, the instructor insures that the students receive sufficient training to assure that the demonstration or experiment is conducted safely. The Radiation Safety Officer is available to conduct or assist in such training.

Annual refresher training is required for:

- Authorized Users working with open sources
- Radiation Workers working with open sources

- Custodial staff
- Facilities Management personnel having occasion to work in the areas where radiation may exist.
- Other personnel who may receive packages.

Custodial staff members are not permitted to clean radiation areas or handle radioactive waste, unless supervised by the RSO or his/her designee.

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## 15.0 Records

The Radiation Safety Officer establishes and maintains the following records:

- List of current Authorized Users.
- Personnel exposure records.
- Radioactive materials inventory and location.
- Radiation survey file.
- Instrument calibration records.
- Training accomplished.
- Information for workers records.
- Certificates of Affirmation for Women.
- Radioactive materials waste records.

Each Authorized User maintains the following records:

- A permanent log of each radioactive isotope in his or her possession, to include: receipt, quantity on hand, and final disposition.
- Waste inventory for each container of waste as waste accumulates.
- Survey results for his/her laboratories.

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## 16.0 Emergency Procedures

**All incidents involving atypical personnel exposures and/or radioactive contamination of personnel or facilities must be reported to the Radiation Safety Officer immediately.**

The Radiation Safety Officer supervises all activities relating to the rectification of the consequences of the incident. The AUR must assist in these efforts.

The Radiation Safety Office notifies DOH of incidents as required by Washington State regulations in WAC 246-221-250. Call (206) NUCLEAR (206-682-5327)

The Emergency Procedures Posting for all radioactive materials areas is shown at the end of this Section.

### 16.1 General Guidelines for Emergencies

The following are general guidelines for emergency response intended to assist Authorized Users and other individuals involved with the handling of radioactive materials:

#### 16.1.1 Procedures For Loss Or Theft Of Radionuclides

In the event of loss or theft of any radioisotope, the following actions are indicated:

- Call and report the matter immediately to the Radiation Safety Officer who will contact the University Police. If you are unable to reach the Radiation Safety Officer directly, contact the University Police.
- Make every effort to locate and recover the material. .
- Provide information to the University Police as to the quantity, size, shape, etc.
- The RSO will brief the University Police on the possible hazards they might encounter and precautions to be taken.

#### 16.1.2 Procedures For Receipt Of A Crushed Or Wet Shipment After Normal Hours

Note that packages are not to be delivered after normal business hours at WWU. If a crushed or wet package of radioactive material is delivered, and it can be rejected, it should be. Otherwise, the following actions are taken:

Do not touch the package.

Evacuate all persons from the area and prevent anyone from entering.

Immediately call the Radiation Safety Officer.

Personnel from the Radiation Safety Office inspect the package using suitable personal protective equipment and instrumentation.

Personnel from the Radiation Safety Office clean up any spill or contamination and make the necessary reports.

#### 16.1.3 Procedures For Minor Spills (< 200 ml or < 100 mCi/ml)

Minor spills are spills of radioactive materials which involve minimal radiation hazard to personnel. In the event of a minor spill, the following actions are taken:

1. NOTIFY - Notify persons in the area that a spill has occurred.
2. PREVENT THE SPREAD - Cover the spill with absorbent.
3. Determine a plan of action including use of personal protective equipment, shielding, remote handling tongs, containment practices, clean-up and waste storage. If there are any doubts about the ability to clean up and decontaminate, contact the Radiation Safety Officer.

4. CLEAN UP – Wear appropriate PPE including disposable gloves. Carefully fold the absorbent paper and pad. Insert into a plastic bag or other suitable container and dispose in the radioactive waste container. Also insert into the plastic bag or container all other contaminated materials such as disposable gloves.
5. Decontaminate the area and dispose of cleaning materials as above
6. SURVEY - with an appropriate contamination survey instrument for the nuclide(s) involved in the spill, checking the area around the spill area, hands, and clothing for contamination. Use wipes and a liquid scintillation counter for H-3, C-14 and S-35.
7. REPORT - Report incident to the Radiation Safety Officer immediately.
  - The Authorized User prepares a complete report detailing the incident to the Radiation Safety Officer.

#### **16.1.4 Procedures For Major Spills ( $\geq 200$ ml or $> 100$ mCi/ml)**

Major spills are spills of radioactive materials which involve significant radiation hazard to personnel. In the event of a major spill, the following actions are taken:

1. CLEAR THE AREA - Notify all persons not involved in the spill to vacate the area.
2. PREVENT THE SPREAD - Dam the spill with absorbent, but do not attempt to clean it up. Confine the movement of all potentially contaminated personnel to prevent any spreading.
3. SHIELD THE SOURCE - If possible, the spill should be shielded, but only if it can be done without further contamination or without significantly increasing your radiation exposure.
4. SECURE THE AREA - Leave the area and lock the door(s) to prevent entry.
  - Permit no further use of the area without approval of the Radiation Safety Officer.
5. CALL FOR HELP - Notify the Radiation Safety Officer immediately.
  - The Radiation Safety Officer directs the decontamination.
  - Consult with the State Radiation Emergency Response – 206-NUCLEAR (206-682-5327)
6. PERSONNEL DECONTAMINATION - Contaminated clothing should be removed and stored for further evaluation by the Radiation Safety Officer. If the spill is on the skin, flush thoroughly with lukewarm water and then wash with mild soap and lukewarm water.
  - **Report:** The Authorized User prepares a complete report including a description of the incident and the actions taken.
    - Include the names and addresses of all contaminated personnel.

### 16.1.5 Procedures for Injuries to Personnel Involving Radiation Hazards

In the event of an injury to personnel which involves radiation hazard or radioactive materials, the following actions are taken:

Wash minor wounds with running water as soon as possible.

Report all radiation accidents which involve injury to personnel, including but not limited to wounds, overexposures, ingestion, and/or inhalation, to the Radiation Safety Officer as soon as possible.

If the Radiation Safety Officer is not available, transport the injured person to St. Joseph Hospital, the nearest emergency medical facility, for evaluation.

The Authorized User must **not** allow any person involved in a radiation injury to return to work without the approval of the attending physician and the Radiation Safety Officer.

The Authorized User prepares a complete report of the accident and any subsequent activity and submits it to the Radiation Safety Officer who provides it to the State.

### 16.1.6 Procedures for Fires or Other Major Emergencies Involving Radiation Hazards

In the event of a fire or other major emergency involving radioactive materials or radiation hazards, the following actions are taken:

- Notify all other persons in the room and leave the building at once.
- If a fire is occurring follow standard emergency procedures. Pull the building alarm.
- Call 911 and/or 650-3911.
- Notify the RSO immediately. The RSO immediately notifies State of Washington Radiation Emergency Response at (206) N-U-C-L-E-A-R (206) 682-5327
- Remain near the site and notify law enforcement and fire fighting personnel of the potential for radiation exposure. In no case should the radiation worker leave the site until qualified experts arrive, unless said worker is seriously injured or incapacitated, and must be removed from the site by emergency personnel.
- If a radiation hazard is not immediately present, attempt to put out fires by approved means.
- Following the emergency, monitor the area and determine the protective actions necessary for decontamination.
- The AUR must **not** allow any person involved to return to work without approval of the RSO.
- The AUR prepares a complete report of the emergency and subsequent activity related to it and submits it to the RSO who provides it to the DOH

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## Radioactive Materials - Emergency Procedures

Fire/Medical Aid ..... 911

University Police ..... x3911

Radiation Safety Officer (RSO) ..... Sue Sullivan - Work: x6512 Office: x3064 Cell: 303-9662 Home: 756-2263

Report all incidents involving abnormal exposure of personnel to ionizing radiation, and/or radioactive contamination of personnel or facilities to the Radiation Safety Officer immediately. The RSO will supervise all activities relating to rectifying the incident. The Authorized User shall assist, as directed, in these efforts. Use the following guidelines in dealing with emergency situations at WWU.

**Loss or Theft of Radioactive Materials.** If radioisotopes are lost or stolen, notify the RSO and University Police immediately. Make all efforts to locate and recover the material. Provide information to the investigating authority as to the quantity, size, shape, etc. The RSO will brief the investigator regarding the hazards that might be encountered and the precautions that should be taken.

**Receipt of a Damaged Shipment of Radioactive Materials.** Handle the article using proper personal protective equipment. Isolate the package from contact by other individuals, and contact the RSO immediately. The RSO staff will deal with the spill or contamination and file the necessary reports.

### Minor Spills (Involving Minimal Radiation Hazard to Personnel)

1. Notify all persons in the area that a spill has occurred.
2. Prevent spread of the spill with appropriate absorbent material.
3. Clean up the spill using disposable gloves and remote handling devices. Insert the contaminated refuse into a plastic bag and dispose of in the appropriate radioactive waste container. Include the disposable gloves and other contaminated clean up materials in the plastic bag.
4. Survey the area with a low-range, thin window G-M survey meter. Include hands, clothing, shoes and areas away from the actual incident.

### Major Spills

1. Clear the area and notify all persons not involved in the spill to vacate the room.
2. Prevent spread of the spill if possible, (e.g. cover with absorbent paper, diatomaceous earth, etc), but do not attempt to clean the area. Confine the movement of all potentially contaminated personnel to prevent spread of the material.
3. Shield the source: if possible, the spill should be shielded but only if it can be done without further contamination and without significantly increasing personal exposure.
4. Exit and close the room. Secure the area to prevent entry by others.
5. Notify the Radiation Safety Office immediately.
6. Contaminated clothing should be removed and stored for further evaluation by the RSO. If the spill is on the skin, the area should be flushed thoroughly with water and washed with mild soap.

### Injuries to Personnel Involving Radiation Hazards

1. Wash minor wounds with running water as soon as possible.
2. All radiation accidents to personnel, (wounds, overexposures, ingestion, inhalation, etc.), must be reported to the RSO as soon as possible.
3. No person involved in a radiation injury may return to work without the approval of the RSO.
4. A complete written history of the accident and subsequent actions taken must be prepared for the RSO and the State Department of Health, Radiation Safety.

### Fires or Other Major Emergencies

1. Call 3911
2. Notify University Police and firefighting personnel of the potential danger of radiation exposure.
3. If a radiation hazard is not immediately present, attempt to control fires by approved means.
4. Monitor all persons involved in combating the emergency. Obtain names and addresses for possible follow-up.
5. Following the emergency, the area will be monitored in order to determine the actions necessary for decontamination.
6. No person will be allowed to return to the area without approval of the RSO.
7. A complete written history of the emergency and the subsequent activities related to it will be prepared for submission to the State Department of Health, Radiation Safety.

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## **Appendix 1 Radiation Safety Forms**

Radiation Survey Record Form1.a  
Receipt of Open Source Radioactive Materials (RAM) to Inventory Form1.b  
Disposition of Open Source Radioactive Materials (RAM) Form 1.c  
Attachment A, Radiation Work Training and Experience Form 1.d  
Request for Report of Radiation Exposure History Form 1.e  
Radiation Safety Information Release Form1.f  
Ionizing Radiation Exposure - Occupational History Form 1.g  
Radiation Safety Instructions to Workers Form 1.h  
Certificate of Affirmation (Women's Reading of NRC guidance) Form 1.i  
Declaration of Pregnancy Form 1.j  
Radioactive Waste Drain Disposal Log Form1.k  
Radioactive Waste Form 1.l

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## Radiation Survey Record

Form 1.a

Building/Room \_\_\_\_\_  
 Authorized User of Radioactive Materials \_\_\_\_\_  
 Surveyor \_\_\_\_\_ Date \_\_\_\_\_

No Survey required\_\_\_\_\_ (No RAM used or stored since last survey)

Survey Required \_\_\_\_\_ Isotope(s) used in Laboratory\_\_\_\_\_

Lab Floor Plan

<p style="text-align: center;"><b>INSTRUMENT SURVEY</b></p> <p>No Instrument Survey taken_____</p> <p>Instrument Survey Taken _____</p> <p style="padding-left: 40px;">Instrument S.N. _____</p> <p style="padding-left: 40px;">Background _____</p> <p style="padding-left: 40px;">Efficiency _____</p> <p style="padding-left: 40px;">Results _____ (cpm) (note location/level on diagram)</p>	
<p style="text-align: center;"><b>WIPE SURVEY: (<sup>3</sup>H, <sup>14</sup>C, <sup>35</sup>S)</b></p> <p>Wipes not taken _____</p> <p>Wipes taken _____</p> <p>Assay results _____ (cpm)</p>	
<p>Corrective Action Necessary</p>	<p>B-lab bench                      RS-RAM sink        S-sink                                * - Contamination        H-fume hood                      G-Normal Waste        RW-Radioactive waste</p>
<p>Individual(s) Notified</p>	<p>Comments</p>



# Receipt of Radioactive Materials (RAM) to Inventory

## Form 1.b

Authorized User of Radioactive Materials

RAM #

Date Received

Lab Room Stored

RAM Isotope Received

RAM Activity Received

(mCi)

**Notes:** The Authorized User, (AUR), may not possess more than the maximum allowable activity of a given isotope, as stated on the WWU's Radioactive Materials License WN-C007-1.

Receipt of High Activity Radioactive Materials must be through the Radiation Safety Officer per Washington Administrative Code (WAC) 246-221-160(2). The external surface of packages must be tested by the Radiation Safety Officer if they are labeled with Radioactive White I, Yellow II or Yellow III labels.

Package Surface Contamination must be surveyed upon receipt per WAC 246-221-160(4):

Condition of Package: Mark an X in the box under any applicable condition:

OK	Punctured	Wet	Crushed	List Other Below
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/>

Radiation measurement units on package label (mR, CPM, etc.)

Measured radiation levels at outer package (include units, mR, CPM, etc.)

Instrument used:

Background Level:

Response Check Source OK:

Measure at Package Surface:

Check that the Packing Slip and Vial Contents agree as shown below:

Radionuclide is the same:

Yes

No

Difference:

Amount is the same:

Yes

No

Difference:

Chemical form is the same:

Yes

No

Difference:

Wipe Results:

Outer Container (pig)

cpm =

dpm

Efficiency =

Survey Results of Packing Material and Cartons/Boxes

cpm

NOTE: If H-3 or C-14 a wipe of inner packaging is sufficient.

Disposition of Packaging Materials after Inspection

Package Surface Activity: Must be <22 dpm/cm<sup>2</sup> if  $\beta$  and/or  $\gamma$ .

Must be <2.2 dpm/cm<sup>2</sup> if  $\alpha$ . (WAC 246-221-160(5)):

If contamination is found, immediately notify WWU's Radiation Safety Officer, who may notify the final carrier, and/or the Department of Health. If contamination is found, action may include cleaning the exterior of the container. If replacement of the order is necessary, notify Radiation Safety before proceeding.

Radiation Safety Officer Signature (only if needed) \_\_\_\_\_

**Back of form**



## Disposition of Open Source Radioactive Materials (RAM) From Inventory Form 1.c

Authorized User of Radioactive Materials \_\_\_\_\_

Ram Isotope Received \_\_\_\_\_ RAM Activity Received \_\_\_\_\_ (mCi)

**RAM #** \_\_\_\_\_ **Date Received** \_\_\_\_\_ **Lab Room Stored** \_\_\_\_\_

This usage inventory and disposition record must be kept for each isotope delivery.

Please return a copy of this document to Environmental Health and Safety (EHS) when all material is in waste or is decayed. If you are giving waste to EHS, please also complete a waste form.

Estimate the activity for each type of use or disposal as shown below

- |                          |   |
|--------------------------|---|
| 1. Solid Dry Waste       | _____ (mCi)                                   |
| 2. Absorbed Liquid       | _____ (mCi)                                   |
| 3. Aqueous Waste         | _____ (mCi)                                   |
| 4. Organic Solvent Waste | _____ (mCi)                                   |
| 5. Sewer Disposal        | _____ (mCi)                                   |
| 6. Vaporization          | _____ (mCi)                                   |
| 7. Decay                 | _____ (mCi)                                   |
| 8. Other                 | _____ (mCi)                                   |
| <b>TOTAL</b>             | <b>_____ (mCi) must equal amount received</b> |

**Comments:**

Authorized User Signature \_\_\_\_\_ Date \_\_\_\_\_

## Back of form

# Attachment A - Radiation Work Training and Experience

Form 1.d

- AUTHORIZED USER
- RADIATION SAFETY OFFICER
- STUDENT USER STUDYING WITH \_\_\_\_\_
- EMPLOYEE USER WORKING FOR \_\_\_\_\_

(Use supplemental sheets if necessary.)

1. NAME OF APPLICANT \_\_\_\_\_

2. DATE \_\_\_\_\_

### 3. Training Received In Basic Radioisotope Handling Techniques

Subject of Training	Where Training Occurred	Date(s) and Duration	Formal Course	On The Job
A. Principles and Practices of Radiation Protection			YES NO	YES NO
B. Characteristics of Ionizing Radiation			YES NO	YES NO
C. Units of Radiation Dose and Quantities of Activity			YES NO	YES NO
D. Radiation Detection Instrumentation and Monitoring Techniques			YES NO	YES NO
E. Biological Effects of Radiation			YES NO	YES NO

### 4. Hands-On Experience with Radioactive Materials

Nuclide	Maximum Amount Used per Experiment	Where Experience Was Gained	Date(s) and Duration Of Experience

**Attachment A (Continued)**

NAME: \_\_\_\_\_ DATE: \_\_\_\_\_

5. Resume of Radiation Work Experience		
Dates of Employment	Employer Name, Address & Supervisor Phone Number	Job Title/Type of Radioactive Materials Use including Nuclides Used

I certify that this attachment is prepared in conformity with Washington State Department of Health, Office of Radiation Protection regulations and that all information contained herein, including any supplements attached hereto, is true and correct to the best of my knowledge and belief.

\_\_\_\_\_  
(Signature)

\_\_\_\_\_  
(Date)



Environmental Studies Building, Room 72  
516 High Street  
Bellingham, Washington 98225-9070  
(360) 650-3064  
[www.wvu.edu/depts/ehs/](http://www.wvu.edu/depts/ehs/)

**SUBJECT: Request for Report of Radiation Exposure History**

Dear Sir or /Madam:

NAME: \_\_\_\_\_

BRANCH OF SERVICE & SERVICE NUMBER: (If Applicable) \_\_\_\_\_

BIRTHDATE: \_\_\_\_\_

SOCIAL SECURITY NUMBER: \_\_\_\_\_

PERIOD OF EXPOSURE: \_\_\_\_\_

The Radiation Safety Office of WWU would appreciate receiving any radiation exposure history, (internal or external), which you may have for the above-named individual. The attached page specifies the type of information we would like to have.

This request is necessary to facilitate control of occupational radiation exposure in accordance with current state and federal regulations.

A statement authorizing release of the requested information is also attached. Thank you for your time and attention to this matter.

Sincerely,

Sue Sullivan, Radiation Safety Officer

Enclosures

## Back of form



NAME: \_\_\_\_\_

**EXPOSURE FROM EXTERNAL SOURCES (Rem)**

Exposure Type	Whole Body (Deep) Rem	Skin (Shallow) Rem	Extremity Rem
Exposure – Current Calendar -Quarter			
Exposure- Current Calendar- Year to Date			
Accumulated Exposure to Date			

**EXPOSURE FROM INTERNALLY DEPOSITED RADIOACTIVE MATERIAL**

Radionuclide	Critical Organ Burden (nCi)	Total Body Burden (nCi)	As of(date)

**Other Comments:**

Name: \_\_\_\_\_

Signed: \_\_\_\_\_

Date: \_\_\_\_\_

## Back of form



## Radiation Safety Information Release Form Form 1.f

### TO WHOM IT MAY CONCERN:

You are authorized to furnish Western Washington University, Bellingham, Washington, any information concerning my radiation exposure history while I was associated with your organization.

Name (printed): \_\_\_\_\_

Date: \_\_\_\_\_

Signature: \_\_\_\_\_

## Back of form



## Ionizing Radiation Exposure - Occupational History Form 1.g

In accordance with provisions of the Washington Administrative Code, Part 246, and the Washington State Department of Health, Division of Radiation Protection, it is necessary to request the occupational exposure history, to ionizing radiation, of every employee that will be working with radioactive materials at Western Washington University.

Please provide the relevant information about your employment history requested in this document. In addition, please sign the attached form authorizing release of said information. Please return both items to the Radiation Safety Office, as soon as possible. Thank you for your attention to this matter.

NAME: \_\_\_\_\_

BIRTHDATE: \_\_\_\_\_

SOCIAL SECURITY NUMBER: \_\_\_\_\_

---

EMPLOYER NAME : \_\_\_\_\_

EMPLOYER ADDRESS: \_\_\_\_\_

\_\_\_\_\_

DATES OF EMPLOYMENT: \_\_\_\_\_ TO \_\_\_\_\_

---

EMPLOYER NAME: \_\_\_\_\_

EMPLOYER ADDRESS: \_\_\_\_\_

\_\_\_\_\_

DATES OF EMPLOYMENT: \_\_\_\_\_ TO \_\_\_\_\_

---

EMPLOYER NAME: \_\_\_\_\_

EMPLOYER ADDRESS: \_\_\_\_\_

\_\_\_\_\_

DATES OF EMPLOYMENT: \_\_\_\_\_ TO \_\_\_\_\_

---

ADDITIONAL INFORMATION: (If necessary, please use the reverse side of this form.)

## Back of form

# Radiation Safety Instructions

## Form 1.h

**WAC 246-222-030 Instructions to workers.**

(1) All individuals likely to receive in a year an occupational dose in excess of 1 mSv (100 mrem):

(a) Shall be kept informed of the storage, transfer, or use of sources of radiation in the licensee's or registrant's facility;
(b) Shall be instructed in the health protection considerations for the individual and potential offspring associated with exposure to radiation or radioactive material, in precautions or procedures to minimize exposure, and in the purposes and functions of protective devices employed;
(c) Shall be instructed in, and instructed to observe, to the extent within the worker's control, the applicable provisions of these regulations, department form RHF-3 "Notice to employees," and license conditions for the protection of personnel from exposures to radiation or radioactive material;
(d) Shall be instructed that any worker or representative of workers who believes that a violation of the regulations, license conditions, or unnecessary exposure to radiation exists or occurred, may request an inspection by the department by oral or written notification. The notification shall set forth specific grounds for the complaint. Any such notification to the department is confidential;
(e) Shall be instructed of their right to notify the department if the individual suspects improper actions by a licensee/registrant, or conditions which may lead to a violation of these regulations, the license/registration, or unnecessary exposure to radiation or radioactive materials;
(f) Shall be instructed that employment discrimination by a licensee/registrant against an employee because of actions described in this chapter is prohibited;
(g) Shall be instructed as to their responsibility to report promptly to the licensee or registrant any condition which may constitute, lead to, or cause a violation of the act, these regulations, and licenses or unnecessary exposure to radiation or radioactive material;
(h) Shall be instructed in the appropriate response to warnings made in the event of any unusual occurrence or malfunction that may involve exposure to radiation or radioactive material; and
(i) Shall be advised as to the radiation exposure reports which workers shall be furnished pursuant to WAC <a href="#">246-222-040</a> .

(2) Records of these instructions described in subsection (1) of this section for all individuals working in, or frequenting any portion of, a restricted area shall be maintained for inspection by the department until further notice. These records shall include a copy of this section, or all the information contained in this section, along with a dated verification signature by the employee stating that the individual has received an explanation of the instructions contained in this section.

(3) In determining those individuals subject to the requirements of subsection (1) of this section, licensees and registrants shall take into consideration assigned activities during normal and abnormal situations involving exposure to sources of radiation which can reasonably be expected to occur during the life of a licensed or registered facility. The extent of these instructions shall be commensurate with potential radiological health protection considerations present in the workplace.

---

By my signature below, I verify that I have read and understand the above instructions to persons using radiation or radioactive materials. I have received an explanation of the instructions.

\_\_\_\_\_  
Printed Name

\_\_\_\_\_  
Signature

Date \_\_\_\_\_

## Back of form



## Certificate of Affirmation Form 1.i

I have been briefed, have read, and understand the information contained in the following documents from the U.S. Nuclear Regulatory Commission:

- NRC Regulatory [Guide 8.13](#), Instruction Concerning Prenatal Radiation Exposure including the Appendix, Questions and Answers Concerning Prenatal Radiation Exposure.

This may be found at the following website [Occupational Health Regulatory Guides](#) by scrolling down to 8.13.

<http://www.nrc.gov/reading-rm/doc-collections/reg-guides/occupational-health/rg/division-8/division-8-1.html>

I was given the opportunity to ask questions and my questions were answered to my satisfaction.

---

Printed Name

---

Signature

---

Date

## Back of form



**Declaration of Pregnancy**  
Form 1.j

To Supervisor: \_\_\_\_\_

In accordance with the Nuclear Regulatory Commission's regulations in Title 10, Code of Federal Regulations, Part 20.1208, "dose to an Embryo/Fetus," I am declaring that I am pregnant. I believe I became pregnant in \_\_\_\_\_ (only the month and year need be provided).

I understand the radiation dose to my embryo/fetus during my entire pregnancy will not be allowed to exceed 0.5 rem (5 millisievert) (unless that dose has already been exceeded between the time of conception and submitting this letter). I also understand that meeting the lower dose limit may require a change in job or job responsibilities during my pregnancy.

\_\_\_\_\_  
Printed Name

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date

## Back of form



## Back of form

**Radioactive Waste Collection Request Form  
Form 1.1**

**WWU Environmental Health & Safety Office**

Label each container with RAM #, Isotope and Activity. Please complete this form and return to the Environmental Health & Safety office, MS 9070. Fax is 650-6514. Call 650-3064 if you have any questions. E-mail: EHS@wwu.edu

Department	Building/Room Number	Telephone	Date
------------	----------------------	-----------	------

I hereby certify that all materials referenced below are fully and accurately described, packaged, and labeled according to the procedures of the Western Washington University Radiation Protection: Principals and Practices.

Name (Please Print)	Signature
---------------------	-----------

							<b>EHS OFFICE USE ONLY</b>			
Solid, Liquid or Vials	Radio-nuclide	Activity (mCi)	Description of Waste (include all chemicals and/or biologicals present)	Number of Containers	Amount of Waste	RAM #	Container No,	Storage Location	Entered	Date Picked Up

Form Rc'd \_\_\_\_\_

Containers picked up: Name \_\_\_\_\_ Date \_\_\_\_\_

Rev. 05/06

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