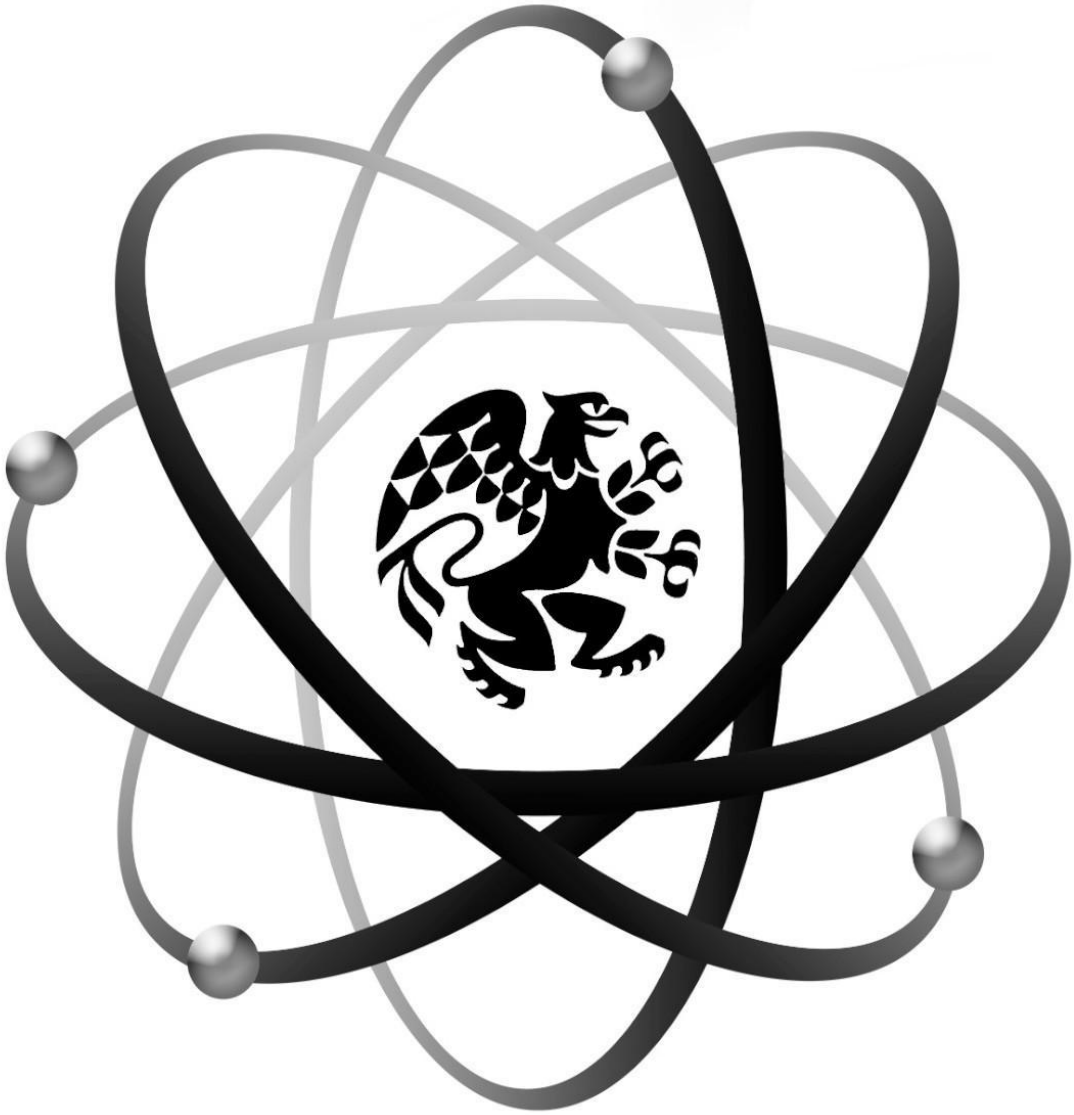
Reed College
Radioactive Materials
Policy and Procedures Manual

July 2024



EMERGENCY INFORMATION

Fire, Ambulance/Rescue, Police..... 911

Community Safety.....(503) 788-6666

Reed Health Services (M-F 9 am - 5 pm).....(503) 777-7281

Radiation Safety Officer (April Sams).....(503) 777-7788

Reactor Director (Jerry Newhouse).....(503) 777-7222

Reed Physical Plant Maintenance.....(503) 777-7283

Mailroom Manager …….....(503)777-7214

Reed Public Affairs. …….....(503)777-7289

Poison Control Center (OHSU).....#, (800) 222-1222

State of Oregon Radiation Protection Services.....#, (971) 673-0490 [see Appendix A]

Oregon Occupational Safety and Health Administration (OR-OSHA)……...#, (503) 378-3272 [see Appendix A]

Please note the location of the following:

Nearest Fire Alarm Pull Station: _____

Nearest Fire Extinguisher: _____

Nearest Emergency Shower/Eyewash: _____

Nearest First Aid Kit: _____

Nearest Spill Kit: _____

Nearest Automated External Defibrillator: _____

Outside Assembly Point Location _____

Shelter-in-Place Location: _____

SDS Locations _____

REVISION HISTORY

July 18, 2024

After external audit:

1. Added appendix A annual limits table to back of document
2. Added appendix B which outlines contamination values.

July 15, 2023

- Minor edits throughout
    - 3.1.10 Removed the reference to a written report and updated to a review of the investigation by the RSC
    - Procedure 3-
        - Removed reference to appendix c.
        - Edited dates and the type of LSC.
- Removed procedure for sink disposal. All sink disposal requests must be granted by the RSO

July 2023 Review:

Updated by Auden Oliveri (Radiation Safety Technician)

Reviewed by April Sams (Radiation Safety Officer

August 23, 2022

- Major formatting restructuring.
    - Sections are now numbered like 3.2.1 instead of 3.b.c
    - Added revision dates, revision history, hyperlink table of contents, etc
- Changed all references to gendered terms (such as pregnant woman) to gender neutral terms
- Forms are now separate from the manual.
- Updated Emergency Contact Information.
- Added more references to the procedures themselves, and also to the federal/state regulations

August 2022 Review:

Updated by Auden Oliveri (Radiation Safety Technician)

Reviewed by April Sams (Radiation Safety Officer

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Reed College Radioactive Materials

Policies

1. RADIATION SAFETY COMMITTEE (RSC)

1.1. RESPONSIBILITIES

1.1.1. Be familiar with all pertinent Oregon rules, the terms of the license, and information submitted in support of the request for the license and its amendments.

1.1.2. Establish a program to ensure that all individuals whose duties may require them to work in the vicinity of radiation or radioactive material (e.g., security, maintenance, and custodial personnel) are properly instructed as required by the Oregon Administrative Rules (OAR) 333-111-0010, part of the Oregon rules for controlling radiation.

1.1.3. Review the training and experience of all individuals who use or handle radioactive materials (RAM) and determine that their qualifications are sufficient to enable them to perform their duties safely and in accordance with the rules and conditions of the license.

1.1.4. Review all requests for authorization to use radiation or radioactive material within the institution on the basis of safety, and approve or deny the requests based on the limitations of the rules, the license, and the "As Low As (is) Reasonably Achievable" (ALARA) principle.

1.1.5. Prescribe special conditions that will be required during a proposed method of use of radioactive material (e.g., requirements for bioassays, physical examinations, and special monitoring procedures).

1.1.6. Review quarterly the summary report of the occupational radiation exposure records of all personnel.

1.1.7. Review annually the summary report of the entire Radiation Safety Program provided by the Radiation Safety Officer (RSO) to determine that all activities are conducted safely, in accordance with Oregon Rules and the conditions of the license, and consistent with the ALARA program and philosophy. The review must include an examination of records, reports from the RSO, results of inspections, written safety procedures, and the adequacy of the management control system.

1.1.8. Recommend remedial action to correct any deficiencies identified in the radiation safety program.

1.1.9. Maintain written minutes of all committee meetings, including members in attendance, discussions, actions, recommendations, and decisions.

1.1.10. Ensure that the radioactive material license is amended when necessary.

1.1.11. Support the RSO in enforcing the rules and procedures specified by the license and procedures.

1.2. ADMINISTRATIVE INFORMATION

1.2.1. The Committee shall meet as often as necessary to conduct its business, but shall meet a minimum of one time per calendar quarter.

1.2.2. Primary membership includes the following:

- One faculty member from each department where radioactive materials are housed, preferably one who uses or stores radioactive materials
- The RSO
- The Assistant RSO, if listed on the Oregon RAM License
- A representative from the Reed Research Reactor facility
- The campus hazardous materials manager
- A representative of the Administration who does not use or store radioactive materials nor is an RSO.

1.2.3. The Administration may appoint alternate members to participate in meetings in the case of absent primary members and may consider appointing adjunct member representatives from security, facilities services, the student body, and other departments.

1.2.4. A simple majority of the primary membership of the RSC is necessary to approve new Principal Users of radioactive materials.

1.2.5. Principal Users (training outlined in Policy 12.2.1) are typically faculty or staff who supervise a lab using radioactive materials, such as Faculty, Researchers, the Reactor Director, the Reactor Operations Manager, the Radiation Safety Officer, or the Assistant Radiation Safety Officer.

1.2.6. The RSO will approve new Authorized Users working under the guidance of a Principal User after the applicant has adequately completed the training and testing requirements described in Policy 12.4.1 and Procedure 8: Personnel Training.

1.2.7. Authorized Users may be students, non-Reed employees, visitors, or others who use radioactive materials under the direction of a Principal User.

1.2.8. Voting may be conducted over electronic mail.

1.2.9. To establish a quorum for voting on issues affecting policy, procedure, or the radioactive materials license, one half of the primary membership, including the RSO and Administration representative, must vote.

2. RADIATION SAFETY OFFICER (RSO) DUTIES

2.1. Be familiar with all applicable laws, rules, and license application guides, and ensure that license applications are properly filled out and submitted in a timely fashion. Ensure that the institutional radiation use and safety programs comply with the license application and conditions.

2.2. Establish and maintain record systems of the following, unless otherwise indicated:

2.2.1. Dosimetry reports

2.2.2. Bi-weekly and/or monthly wipe tests

2.2.3. Bi-weekly and/or monthly surveys of lab areas (maintained by RSO and/or Reactor Director)

2.2.4. Source wipe tests (maintained by RSO and/or Reactor Director)

2.2.5. Semi-annual inventories (maintained by RSO and/or Reactor Director)

2.2.6. Annual audits of radiation safety program

2.2.7. Instrument calibrations (maintained by Reactor Director)

2.2.8. Radiation Safety Committee minutes and communications

2.2.9. State inspections and communications

2.2.10. Principal User authorizations

2.2.11. Receipt, Use, and Disposal Logs

2.2.12. Training records

2.2.13. Changes to the Reed College Radioactive Materials License (ORE-90010)

2.2.14. Radioactive waste off-site disposal records (maintained by Reactor Director)

2.2.15. Lab close-out records

2.2.16. Decommissioning

2.3. Prepare an annual report presented to the RSC that reviews and summarizes all activities pertaining to radioactive materials, including training, surveys, wipe test dates, waste disposal, ordering of materials, and other information.

2.4. Review personnel dosimetry reports quarterly or more often if required. Advise individual radiation workers of any unusual exposure. Determine the cause of all overexposures, as defined in Policy 3.1.9, to preclude recurrence.

2.5. At the conclusion of each calendar quarter, perform a review of occupational exposure to users and workers to determine that the exposures are within the limits established for the ALARA program. At the conclusion of each calendar year and upon end of employment, apprise each employee of their annual accrued dose.

2.6. Ensure that individuals working with radiation have appropriate protective devices such as shielding, ventilation, clothing, gloves, remote handling equipment, dosimeters, instrumentation, and facilities, which aid in keeping exposures ALARA.

2.7. Ensure that all individuals who work with, or in the vicinity of, radioactive material or sources of radiation have sufficient training and experience to enable them to perform their duties safely and in accordance with the law, rules, and the conditions of the license.

2.8. Ensure that individuals use radioactive material and radiation in a safe manner and in compliance with the law, rules, and the conditions of the license. This includes reviewing, as necessary, training programs, equipment, facilities, supplies, and procedures. (See Procedure 1: *Safe Use of Radioactive Materials*.)

2.9. Ensure that the use of radioactive material is consistent with the ALARA principle and program.

2.10. Identify program problems and solutions.

2.11. Act as liaison with regulatory authorities by doing the following:

2.11.1. Provide assistance during inspections and audits.

2.11.2. Communicate with state agencies as indicated by the following:

2.11.2.1. Submit a written amendment request to State of Oregon Radiation Protection Services before making any change that would render the current Radioactive Materials License inaccurate.

2.11.2.2. Notify the State of Oregon Radiation Protection Services:

- Within 5 days of any positive leak test result of a sealed source.
- Within 30 days in a report stating remedial action taken after an accident or incident.

2.11.2.3. Notify the State of Oregon Radiation Protection Services and/or Oregon Occupational and Safety Administration (OR-OSHA) of any

radiation accident or incident that meets the requirements summarized in Appendix A: Emergency Notifications.

2.12. Ensure a semi-annual inventory (Form 1) is performed of all sealed sources received or possessed and all radioisotopes in authorized areas, in accordance with OAR 333-102-0910.

2.13. Maintain an inventory control of radioisotopes at the institution and ensure that license quantities are not exceeded.

2.14. Ensure all surveys, calibrations, and leak tests are performed on time.

2.15. Post conspicuously the Oregon Department of Human Services form, "Notice to Employees," and other items required under OAR 333-111, as well as notices of Items of Noncompliance resulting from Radiation Safety Committee inspections.

2.16. Supply employers of terminated occupationally-exposed personnel with radiation exposure records as required.

2.17. Keep records of receipts of incoming radioisotopes and surveys of incoming and outgoing shipments.

2.18. Ensure that all incoming and outgoing radioactive material shipments are properly packaged and labeled according to DOT requirements, and that proper shipping papers accompany shipments.

2.19. Ensure that radioactive materials are disposed of properly and that records are maintained of all radioactive wastes disposed (See Procedure 5: *Waste Disposal*).

2.20. In conjunction with the Radiation Safety Committee, continually review the radiation safety program for adherence to ALARA concepts.

2.21. Ensure that all workers dealing with radioactive materials follow the safety program.

2.22. Investigate any deviation from the program and take any necessary action.

2.23. Schedule briefings and educational sessions to inform workers of the following radiation safety rules and procedures:

2.23.1. For all new personnel working with or around radioactive materials.

2.23.2. With each change in license condition or safety program which will affect the employee.

2.23.3. Provide refresher advisories for all personnel. This includes instruction in the ALARA program and philosophy.

3. PERSONNEL DOSIMETRY AND BIOASSAY PROGRAMS

3.1. DOSIMETRY PROGRAM

3.1.1. Any individual who is likely to exceed 10% of their exposure limit is required as per OAR 333-120-0210 to receive personal dosimetry. However, the policy of Reed College is more conservative as indicated in the following paragraphs. Appendix B: Worker Exposure Levels, shows both regulatory and recommended exposure limits.

3.1.2. All individuals who are occupationally exposed to penetrating ionizing radiation on a regular basis will be issued appropriate dosimetry monitoring devices, which will be processed by a National Voluntary Laboratory Accreditation Program (NVLAP) certified contract service at least on a quarterly basis.

3.1.2.1. Reed's dosimetry, including whole body, ring, and fixed, are provided and processed by Landauer, who produces TLDs and OSLDs. They are exchanged every quarter by the Reactor Staff.

3.1.3. The RSO and/or Reactor Director will review, sign, and date all exposure reports promptly upon their receipt.

3.1.4. All individuals who potentially may be occupationally exposed to penetrating ionizing radiation on an occasional basis will be issued a personal self-reading dosimeter (e.g., an Electronic Personal Dosimeter (EPD).

3.1.5. Individuals who work exclusively with low-energy beta emitters will not be issued radiation dosimeters.

3.1.6. Classes that perform occasional experiments with microcurie-level sources will not be issued dosimeters. Past data show that no individual exposures greater than ten percent of the allowable annual limit have occurred in these classes.

3.1.7. Whole body and ring dosimetry will be issued and exchanged quarterly.

3.1.8. The RSO or Reactor Director will maintain a record of personnel dosimetry records. Each individual who received a measurable dose will receive a report of their annual dose at the end of the fiscal year and at the end of employment.

3.1.9. Any reported whole body dose greater than **50 mrem per quarter** or any extremity dose greater than **100 mrem per quarter** will be investigated by the RSO and/or Reactor Director to determine the cause of the exposure.

3.1.10. A review of the investigation will be discussed at the next RSC meeting.

3.1.11. The RSO or designee may investigate any dose at their discretion.

3.1.12. If a user notifies the RSO in writing that they are pregnant, the RSO will take extra measures, such as providing a second badge issued monthly, to ensure the fetus receives less than 500 mrem during the gestation period, as per 10 CFR 20.1208(a). This notification of pregnancy can be revoked at any time and is completely voluntary.

3.2. BIOASSAY PROGRAM

3.2.1. Any individual using tritium or working in an area where tritium intake is possible will inform the RSO or designee prior to the activity when any of the following conditions apply:

3.2.1.1. When handling organic H-3 in single packages with an activity of 10 millicuries (10 mCi, 370 MBq) or more

3.2.1.2. When handling inorganic H-3 in single packages of 50 millicuries (50 mCi, 1.8 GBq) or more

3.2.1.3. When deemed necessary by the RSO or designee

3.2.2. Each individual will submit a urine specimen to the RSO or Assistant RSO before work begins in order to establish a baseline.

3.2.2.1. The individual will submit a urine sample within 12-48 hours of opening the container or otherwise using the material.

3.2.2.2. The sample will be analyzed with a liquid scintillation counter, using procedures developed by Oregon State University Radiation Center in their RCHPP 14.

3.2.3. Any individual handling 1 millicurie (1 mCi, 37 MBq) or more of Iodine-125 will inform the RSO prior to the activity and will undergo a thyroid scan before work begins in order to establish a baseline.

3.2.3.1. The individual will undergo an additional thyroid scan within 24-48 hours of opening the container or otherwise using the material.

3.2.3.2. The RSO will arrange the scan with Oregon Health and Science University (OHSU) Radiation Safety Lab.

4. SAFE USE OF RADIOACTIVE MATERIALS

4.1. Areas where radioactive materials are stored, prepared, and used will be monitored for contamination in compliance with Procedure 1: Safe Use of Radioactive Materials.

4.2. Individuals found in violation of these rules will be subject to sanctions determined by the Radiation Safety Committee.

5. EMERGENCY PROCEDURES

5.1. The RSO and/or designee will take charge in all emergency situations in the event of major or minor spills (as defined in Procedure 2: *Emergencies*) or release of radioactive material, to ensure correct emergency decontamination and protection procedures are carried out.

5.2. The RSO will also evaluate the situation that led to the emergency to reduce the chance of recurrence and will submit a report to the State of Oregon Radiation Protection Services if necessary (see Procedure 2: *Emergencies*).

5.3. In addition, the Reactor facility has their own Emergency Plan, developed in accordance with 10 CFR 50.47, and Emergency Implementation Procedures (EIPs). These procedures are specific to the Reactor facility and their uses of RAM, and should be used when dealing with emergencies pertaining to the Reactor.

6. LEAK TEST PROGRAM FOR SEALED SOURCES

6.1. The Reactor Director or designee shall perform leak tests of sealed sources per Procedure 3: *Sealed Source Leak Test.*

7. AREA SURVEYS

7.1. Individuals using radioactive materials must conduct bi-weekly (interval not to exceed 19 days) surveys per Procedure 4: *User Surveys*.

7.2.

7.4. Areas where radioactive materials are stored must be surveyed at least once a month.

8. INVENTORY

8.1. REQUIREMENTS

8.1.1. Principal Users shall conduct a semiannual physical inventory of all radioactive material possessed under the license.

8.1.2. Inventories shall be submitted to the RSO semiannually (interval not to exceed 32 weeks). Form 1: *Semi-Annual Inventory* or an equivalent form may be used.

8.1.3. Each inventory shall include the date of the inventory, the name of the Principal User completing the inventory, the quantity and nuclide of materials inventoried, the chemical form of the material, the identification number of the material (if applicable), and its physical location. Sealed sources must also be inventoried.

8.2. EXEMPTIONS

8.2.1. Radioactive material that was made radioactive in the Reactor facility, either samples or materials licensed under their NRC facility license (R-112, Docket No. 50-288), may be excluded from semiannual inventories.

9. WASTE DISPOSAL

9.1. INTRODUCTION

9.1.1. Waste disposal is a very expensive and strictly regulated process. To ensure compliance with regulations and to minimize releases of radioactivity to the environment, Reed College requires that users of radioactive materials follow the procedures described in Procedure 5: *Waste Disposal*. Reed College strives to reduce the amount of radioactive waste generated.

9.2. RESPONSIBILITIES

9.2.1. PRINCIPAL USERS

9.2.1.1. Through supervision, instruction, and careful monitoring, ensure that no radioactive materials are discarded as ordinary trash or as other non-radioactive hazardous waste.

9.2.1.2. Minimize the disposal of non-radioactive materials as radioactive waste.

9.2.1.3. Minimize the production of radioactive waste and the cost of disposal (e.g., by using materials with short half lives).

9.2.1.4. Follow disposal steps established in Procedure 5: *Waste Disposal*. Properly package and label waste for transfer to the campus radioactive waste storage facility.

9.2.1.5. Sink disposal shall not be used unless a plan is developed in consultation with the RSO.

9.2.1.6. Restrict sink disposal to sinks registered with the RSO. Ensure that the disposal is within authorized limits and the wastes are soluble or dispersible in water. Keep records of disposals.

9.2.1.7. Train all new Authorized Users for whom they are responsible in proper laboratory techniques regarding radioactive materials.

9.2.2. AUTHORIZED USERS

9.2.2.1. Follow instructions for packaging and labeling radioactive waste per Procedure *5: Waste Disposal*.

9.2.2.2. Ensure that radioactive materials are never placed into regular trash containers or wastebaskets, or disposed through any other method that is not controlled with respect to radioactivity.

9.2.2.3. Minimize the amount of radioactive waste generated. Record the proper information for each sink disposal of radioactive material as described in Procedure 5: *Waste Disposal*. Activity must be within acceptable limits and the material must be soluble or dispersible in water and non-hazardous.

9.2.3. RADIATION SAFETY OFFICER

9.2.3.1. Keep a file of all radioactive waste disposal regulations and ensure the college follows them.

9.2.3.2. Receive all appropriately labeled radioactive wastes generated at the college, which require disposal outside the laboratory. Package and label them for appropriate disposal.

9.2.3.3. Keep detailed records of amounts and methods of disposal of radioactive wastes as described in Procedure 5: *Waste Disposal*.

9.2.3.4. Monitor and record all releases from decay-in-storage per Form 5: *Decay-In-Storage Log* or the Reed Research Reactor Irradiation Request Form (RRR SOP 10A)

10. RADIOACTIVE MATERIALS PACKAGES

10.1. All radioactive material packages will be received and surveyed in accordance with the steps in Procedure 6: *Radioactive Materials Package Ordering and Receipt*.

11. AUDITING RADIOACTIVE MATERIALS

11.1. The Radiation Safety Committee in conjunction with the Radiation Safety Officer will continually review the content and implementation of the Reed College Radioactive Materials Program for efficiency and effectiveness in ensuring a safe working environment.

11.2. The overall Reed College Radioactive Materials Program will be audited annually for content completeness, including the RSO record keeping and the annual report. This audit will be conducted either by the Radiation Safety Committee or by an outside consultant.

12. PERSONNEL TRAINING PROGRAM

12.1. INSTRUCTION

12.1.1. Instruction will take place at the following times:

- Before assuming duties with, or in the vicinity of, radioactive materials.
- During refresher training.
- Whenever there is a significant change in duties, rules, or the terms of the license.

12.2. PRINCIPAL USERS

12.2.1. Principal Users will be trained in accordance with Procedure 8: *Personnel Training* which requires new Principal Users to pass an examination and all Principal Users to fill out Form 8: *Application for Use of Radioactive Materials* before using radioactive materials.

12.3. AUTHORIZED USERS

12.3.1. Authorized Users may be students, non-Reed employees, visitors, or others who use radioactive materials under the direction of a Principal User.

12.3.2. Minors (<18 years of age) are not permitted to work with radioactive materials.

12.3.3. Authorized Users will be trained in accordance with Procedure 8: *Personnel Training* and will be assigned to work with a Principal User.

12.4. ANCILLARY PERSONNEL

12.4.1. Those employees whose duties may bring them in the vicinity of the radioactive materials (e.g., custodians, maintenance personnel, security officers) will be trained in accordance with Procedure 8: *Personnel Training* as part of their Right-To-Know training.

12.5. REFRESHER TRAINING

12.5.1. A triennial overview (interval not to exceed 156 weeks) of the Reed College Radioactive Materials Policy and Procedures manual will be presented to all active Principal Users, and Authorized Users outside of the Reactor Training Program.

12.5.2. This overview will require a retest.

12.5.3. Inactive Principal Users will receive refresher training and retesting before resuming use of radioactive materials.

12.5.4. Authorized Users within the Reactor Training Program will receive continuous training on health physics and radiation safety as part of their licensing process, which includes homework/testing.

12.5.5. All users will receive refresher training whenever significant changes to duties, rules, or the terms of the license occur.

13. CALIBRATION OF SURVEY INSTRUMENTS

13.1. Instruments will be calibrated in accordance with Reed Research Reactor SOP 43 or other procedures approved by the Reactor Operations Committee.

13.2. All instruments will be calibrated by the Reactor staff or sent out to an outside company to be calibrated.

13.3. Instruments shall be calibrated at the minimum annually, unless otherwise designated by the manufacturer or a principal user.

14. MONITORING, CONTROL, AND SECURITY

14.1. MONITORING

14.1.1. Per Procedure 4, the RSO or designee will conduct bi-weekly surveys of areas where radioactive materials are prepared or used and at least a once a month survey for radioactive materials in storage.

14.1.2. Bi-weekly surveys are to be completed in intervals not to exceed 19 days; monthly not to exceed 40 days.

14.1.3. The surveyor will use Form 2: *Radiation Survey Report* to report wipe and survey findings.

14.1.4. The location of wipes or surveys taken will be noted on the form.

14.1.5. A visual inspection of the work area will be completed at the time of the survey.

14.1.6. Any violations of proper work procedures will be noted and reported to the Principal User.

14.2. CONTROL

14.2.1. Violations found during the survey will be discussed with the Principal User.

14.2.2. Three violations by any Principal User in a calendar year may result in a temporary suspension of radioactive materials authorization.

14.2.3. The Radiation Safety Committee shall determine the length of suspension.

14.2.4. Serious violations (e.g., mouth pipetting, use of unauthorized radioactive materials, unauthorized users of radioactive materials, unauthorized waste disposal, excessive contamination) may result in immediate suspension of radioactive materials authorization.

14.2.5. The situation will be reviewed and a determination made by the Radiation Safety Committee.

14.3. SECURITY

14.3.1. Entrances to areas that contain radioactive materials must be closed and locked at all times when the area is unoccupied, regardless of the length of time the area remains unoccupied

15. RECORDKEEPING

15.1. The RSO, Reactor Director, or designee will keep records related to the use of radioactive materials.

15.2. These records are listed in Appendix F: *Records to be Retained.*

15.3. The records required by Oregon Administrative Rules include:

15.3.1. The radiation program (OAR 333-120-0610)

15.3.2. Surveys and leak tests (OAR 333-120-0620)

15.3.3. Occupational dose (OAR 333-120-0630)

15.3.4. Planned special exposures (OAR 333-120-0640)

15.3.5. Individual monitoring results (OAR 333-120-0650)

15.3.6. Doses to individual members of the public (OAR 333-120-0660)

15.3.7. Waste disposal (OAR 333-120-0670)

15.3.8. Inventory (OAR 333-102-0910).

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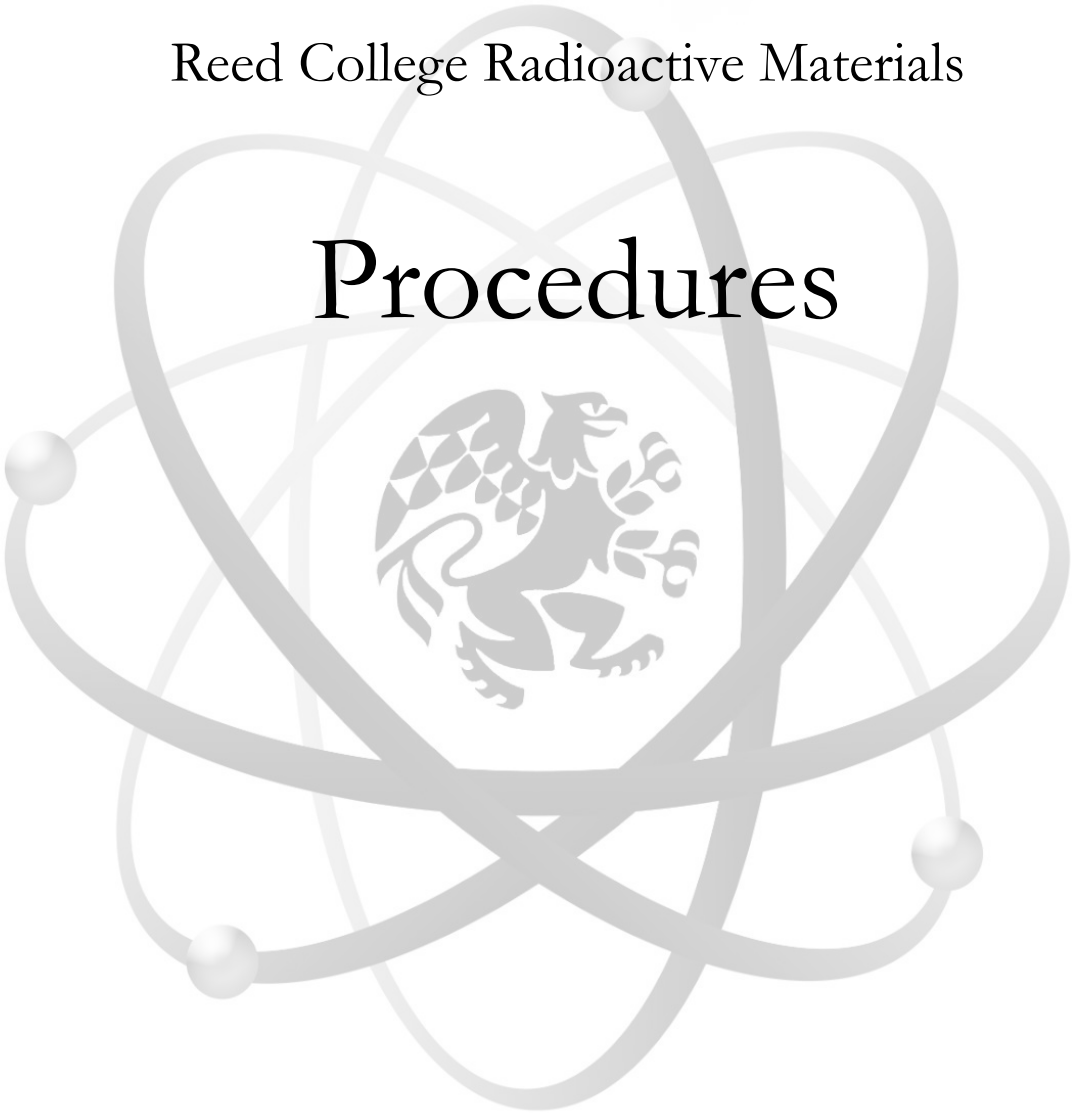
Reed College Radioactive Materials

Procedures



PROCEDURE 1: SAFE USE OF RADIOACTIVE MATERIALS

OAR 333-102, 333-120

1. GENERAL PROCEDURES

1.1. Verify that individuals who handle radioactive materials have completed their radioactive materials training and work in areas that have been approved through the principal user application process.

1.2. Minors (<18 years of age) are not allowed to handle radioactive material or enter a Radiation Area, unless otherwise specified.

1.3. Wear personal protective equipment, including the following, when handling radioactive materials other than sealed sources:

1.3.1. Lab coats, coveralls, or other means of protecting street clothes.

1.3.2. Chemically compatible disposable gloves.

1.3.3. Wear closed-toe shoes and long pants or other clothing that covers the legs when working with radioactive materials.

1.3.4. Use suitable shoe covers if canvas shoes are worn when working with radioactive liquids.

1.3.5. Wear eye protection (safety glasses with side shields, splash goggles) when working with radioactive liquids.

1.4. Monitor hands and clothing for contamination when using unsealed gamma and beta emitting radionuclides that can be detected with a GM meter. Monitor after completing the procedure and before leaving the area.

1.5. Never eat, drink, smoke, chew gum, or apply cosmetics/lip balm in areas where unsealed radioactive materials are used or stored.

1.6. Never store food, drink, or personal effects in areas used for unsealed radioactive material storage.

1.7. Securely mark, adequately shield, and properly mark radioactive materials transported through hallways. Dispersible radioactive materials require secondary containment (tray, bucket, bag, beaker, etc.) when transported through hallways or within the lab.

1.8. Wear personnel monitoring devices at all times while in areas where gamma and beta emitting radionuclides with sufficiently high energies are used or stored.

1.9. When not worn to monitor occupational exposures, store personnel monitoring devices in the workplace in a designated low-background area.

1.10. Do not remove the personnel monitoring devices from the workplace or allow anyone other than the workers to whom they were assigned to wear them.

1.11. Place radioactive waste only in designated, labeled, and properly shielded receptacles.

1.12. Never mouth pipette.

1.13. Conduct regular surveys of work areas using a radiation detection survey meter whenever gamma and beta emitting radionuclides with sufficiently high energies are in use. Results will be recorded on Form 2: Radiation Survey Report as described in Procedure 4: User Surveys.

1.14. Keep radioactive solutions in their shielded and clearly labeled containers. Labels must include the isotope, amount, name of the compound, other related hazard information (e.g., Radioactive), and the date and time of receipt or preparation. Record data on Form 3: Receipt, Use and Disposal Log.

1.15. Label all equipment (e.g., pipettes, glassware, automatic pipettors, etc.) used with radioactive materials as such. Do not use them for other purposes until they have been decontaminated.

1.16. Only individuals who have completed Authorized or Principal User training as described in Procedure 8: *Personnel Training* can handle radioactive material in labs recognized through a Principal User's application.

2. SPECIFIC PROCEDURES

2.1. Tritium (H-3)

2.1.1. Organic compounds with activity of 10 millicuries (10 mCi, 370 MBq) or more, or inorganic compounds with activity of 50 millicuries (50 mCi, 1.8 GBq) or more:

2.1.1.1. Carry out all work in a hood.

2.1.1.2. Balance activity in waste, product, etc. to account for total starting activity.

2.1.2. Inform the RSO before handling organic H-3 in single packages with activity of 10 millicuries (10 mCi, 370 GBq) or more, or inorganic H-3 in single packages of 50 millicuries (50 mCi, 1.8 GBq) or more.

2.1.3. Submit to the RSO or designee a urine sample before work begins to establish a baseline, then submit another urine specimen to the RSO within 12-48 hours of opening the container or otherwise using the material.

2.1.4. The sample will be analyzed with a liquid scintillation counter, using procedures developed by Oregon State University Radiation Center in their RCHPP 14.

2.2. Radioactive Iodine

2.2.1. For all iodine compounds regardless of activity, unless specified:

2.2.1.1. Carry out all work in a hood.

2.2.1.2. Wear double gloves.

2.2.1.3. Double bag all wastes.

2.2.2. Inform the RSO before handling 1 millicurie (1 mCi, 37 MBq) or more of I-125.

2.2.3. Have a thyroid scan performed before work begins to establish a baseline, and again within 24-48 hours of opening the container or otherwise using the material.

2.2.4. The RSO will arrange the scan with Oregon Health Sciences University Radiation Safety Lab.

3. ALARA- AS LOW AS REASONABLY ACHIEVABLE

3.1. The ALARA philosophy is one of the basic principles of Health Physics.

3.2. Based on the principle that any dose of radiation, no matter how small, can increase the risk of negative biological effects, it says simply that users must consider the potential risk and the benefit to be gained by each action taken.

3.3. All actions should be designed to minimize risk (i.e. the radiation dose).

3.4. This is the case regardless of whether any regulatory limits are approached.

3.5. Federal and state governments support this philosophy, as well as the Radiation Safety Committee for work at Reed College.

4. HISTORICAL RADIATION EXPOSURES

4.1. The highest annual whole-body radiation exposure at Reed was about 200 mrem (well under the 10CFR20 limit of 5000 mrem) and was received by the Reactor

Health Physicist while performing an operation requiring close handling of a very large source.

4.2. Only a few individuals have received whole-body exposures of more than 100 mrem per year; most have been far below that, and many have recorded whole-body exposures of zero.

4.3. There is no reason why doses cannot be kept just as low in the future.

5. WHAT TYPES OF ACTIONS CONSTITUTE ALARA ACTIONS?

5.1. The following are examples only. Think about your work, and use your knowledge, background, and imagination.

5.1.1. When samples are irradiated in the reactor, they are to be left in the rotary specimen rack until either the experimenter needs the samples or the reactor needs to be prepared for other purposes. Earlier removal will inherently result in higher radiation doses without added benefit.

5.1.2. If you are carrying a radiation source and someone asks you a question, set the source down in a safe place and step back until your conversation is completed. Preferably, delay the conversation until the source is secured at its intended destination.

5.1.3. When handling radioactive samples, use tongs or place them in wooden blocks. Remember that most of these materials are beta emitters. The range of beta particles in material of unit density (i.e., 1 g/cm3) is about 1 cm. If the first centimeter is part of your finger, doses will be high; if it is wood, your beta dose may be very close to zero.

5.1.4. Work efficiently, NOT hastily. The longer it takes to do a job, the higher the dose, BUT the need to redo a job or to clean up a spill resulting from hasty work can significantly INCREASE total dose.

5.1.5. PLAN AHEAD! This is the most important ALARA aid. Discuss the entire operation with your coworkers before you begin. Know exactly who is responsible for what. If possible, conduct a dry run with non-radioactive material until the operation runs smoothly. If anything goes wrong during the actual operation, do not panic. Simply set things down gently, back off, and regroup.

6. PERSONNEL MONITORING

6.1. The following specific actions will help ensure ALARA.

6.1.1. Anyone who enters a High Radiation Areas (> 100 mrem/hr at 30 cm from source) must wear personally issued whole body (badge) and extremity (ring)

dosimetry. A temporarily issued Electronic Personal Dosimeter (EPD) is not sufficient. (See OAR 333-120-0210 (1) (d).)

6.1.2. Any operation which has the potential to expose an individual to a whole-body dose of 10 mrem shall be performed by or under the direct supervision of the Principal User, Radiation Safety Officer, Reactor Director, or Operations Manager.

6.1.3. Any whole body dose in excess of 50 mrem in a quarter or an extremity dose in excess of 100 mrem in a quarter shall be investigated by the Radiation Safety Officer.

PROCEDURE 2: EMERGENCIES & CONTAMINATION EVENTS

OAR 333-120-0720

1. DEFINITIONS

1.1. A **minor spill** of radioactive materials is defined as less than 50 microcuries (μCi) or about 1.11×10^7 counts per minute (assuming efficiency = 10%) and presents little to no radiation or other hazard to personnel or the environment.

1.2. A **major spill** of radioactive materials is defined as more than 50 microcuries (μCi) or about 1.11×10^7 counts per minute (assuming efficiency = 10%) In addition, if someone is injured or the spill poses a significant threat to the safety and health of employees in the immediate vicinity or the environment, it is a major spill.

1.3. Note: $50\ \mu Ci \times \frac{2.22 \times 10^6\ dpm}{1\ \mu Ci} \times efficiency_{detector} = cpm_{\geq background}$

2. MINOR SPILLS

2.1. Immediately notify all other persons in the room.

2.2. Confine the spill and clearly mark the boundary of the spill.

2.3. Survey yourself and all other persons in the vicinity. Decontaminate personnel before equipment or surfaces. For ALARA reasons, DO NOT stand near the spill and be careful to avoid spreading contamination.

2.4. Limit access to the contaminated area to people aiding in cleanup. Do this by locking doors or posting signs and/or individuals at laboratory entrances.

2.5. For liquid spills:

2.5.1. Don two layers of protective gloves, eye protection, and other personal protective equipment per Procedure 1, section A.

2.5.2. Cover the spill with absorbent paper or use a lab spill kit.

2.6. For dry spills:

2.6.1. Don protective gloves.

2.6.2. Cover the spill with damp absorbent paper, taking care not to spread the contamination.

2.6.3. Decontaminate per Procedure 2 section 9 (Decontamination).

2.6.4. Notify the Radiation Safety Officer (RSO).

2.6.5. Permit no person to resume work in the area until a survey is done.

3. MAJOR SPILLS

3.1. Notify all persons not involved in the spill to vacate the room at once. Alert the nearest person to contact the RSO.

3.2. If the spill is liquid and hands are protected, right the container. Work to avoid personal contamination, prolonged exposure, or spread of the spill. Consider the potential for airborne radiation. Cover the contaminated area and an additional two foot perimeter with absorbent paper and clearly mark a clean line unless hazardous to do so.

3.3. Step away from the work area to lower radiation dose rate.

3.4. Survey yourself and other personnel involved thoroughly.

3.5. Evacuate the room. If possible, survey personnel before evacuation. Do not spread contamination outside of the lab.

3.6. Prevent access to the room by locking doors or posting signs and/or individuals at laboratory entrances.

3.7. Take immediate steps to decontaminate personnel involved as necessary.

3.8. Survey all personnel and areas adjacent to the lab. Consider using an air monitor to identify airborne contamination. Control the spread of contamination outside of the lab and decontaminate if necessary.

3.9. Perform decontamination under the supervision of the RSO or other qualified personnel designated by the RSO. Perform bioassay if required by Policy Section 3.2: Bioassay Program.

3.10. Permit no person to resume work in the area until a survey is completed and approval of the RSO is obtained.

3.11. Write a complete history of the accident and subsequent activity for the laboratory records, using Form 6B: Contamination Report.

4. SKIN CONTAMINATION

4.1. Begin decontamination as soon as possible. Use mild soap and tepid water. Wash the affected area several times. Do not scrub, as strong scrubbing will abrade the skin, which can lead to increased penetration of the contamination.

4.2. Have the nearest non-contaminated person (if available) contact the RSO.

4.3. If hair becomes contaminated, immediately wash with soap and water. Because hair can very easily spread contamination, take care that hair does not come in contact with anything else.

4.4. Make note of initial and subsequent contamination levels. Save wash water for analysis.

4.5. Write a complete history of the accident and subsequent activity for the laboratory records, using Form 6B: Contamination Report or Reactor Form SOP 50A: Personnel Contamination Form.

5. EYE CONTAMINATION

5.1. Flush eyes thoroughly (approximately 15 minutes) with isotonic solution (if available), otherwise, use water. Roll the eyelid back as far as possible.

5.2. Seek medical attention.

5.3. Notify RSO.

5.4. Write a complete history of the accident and subsequent activity for the laboratory records, using Form 6B: Contamination Report or reactor form SOP 50A: Personnel Contamination Form.

6. NOSE OR MOUTH CONTAMINATION

6.1. Immediately flush nose and mouth with water. Take care not to ingest the rinse.

6.2. Notify RSO.

6.3. Write a complete history of the accident and subsequent activity for the laboratory records, using Form 6B: Contamination Report or reactor form SOP 50A: Personnel Contamination Form.

7. CLOTHING CONTAMINATION

7.1. Contact the RSO or Reactor Director for a pair of disposable booties. Do not walk in contaminated shoes since this will spread the contamination

7.2. When the shoes are covered, walk to a sink, remove shoes, and clean the soles with soap and water.

7.3. Survey the area to find the parts of the floor that are contaminated and clean them per Procedure 2 section 9 (Decontamination).

7.4. Write a complete history of the accident and subsequent activity for the laboratory records, using Form 6B: Contamination Report or reactor form SOP 50A: Personnel Contamination Form.

8. RELEASE OF AIRBORNE OR VOLATILE RADIOACTIVITY

8.1. Alert everyone in the vicinity of the release; keep unneeded persons out of the affected area.

8.2. Evacuate the room and take whatever steps to contain the contamination that can be done safely and immediately, e.g. close windows and doors, turn off fume hood.

8.3. Contact the RSO or Reactor Director.

8.4. Request that evacuees remain nearby until cleared by RSO or designee.

8.5. Check all people who were in the area at the time of the release for contamination. If/when contamination is found, decontaminate per Procedure 2, section 7 (Clothing Contamination) above.

8.6. If/when contamination is found in the room, begin decontamination at the nearest sink following the steps below.

8.7. Write a complete history of the accident and subsequent activity for the laboratory records, using Form 6B: Contamination Report.

9. DECONTAMINATION

9.1. Supplies:

9.1.1. Plastic garbage bags.

9.1.2. Colored tape.

9.1.3. Disposable absorbent material.

9.1.4. Cleaning detergents (Simple Green works well).

9.1.5. Bucket for water (if needed).

9.1.6. Protective clothing (possibly several layers) including booties, gloves, and safety glasses. If the spill is liquid, the protective suits should be plastic-backed.

9.1.7. Appropriate meter (such as a GM meter) and wipes.

9.2. Pre-decontamination:

9.2.1. Secure area from traffic. Locate and mark off all contaminated areas. Draw a map of the room or area marking contaminated areas if needed.

9.2.2. For H-3 spills, wear booties and gloves and take wipes of the room for analysis in the liquid scintillation counter (LSC) in order to determine the areas of contamination.

9.2.3. Don protective clothing. 2-3 pairs of gloves and booties may be necessary.

9.2.4. Survey just outside the contaminated room with a GM meter to ensure the contamination has not spread.

9.3. Decontamination:

9.3.1. Start cleaning at the edge of the contaminated area and work inward.

9.3.2. Absorb standing liquids.

9.3.3. Apply a cleaning solution. Leave for 1-2 minutes.

9.3.4. Wipe up the solution moving the wipe stroke inwards, thus continually reducing the borders of the contamination.

9.3.5. Use damp absorbent paper to wipe up dry or powder contamination.

9.3.6. Place used cleaning rags/materials in a plastic garbage bag, marked with a Radioactive Material sticker.

9.3.7. Do not remoisten absorbent paper. Do not allow the cleaning solution to spread to non-contaminated areas (e.g., drip over clean lines).

9.3.8. Only use absorbent materials and rags once.

9.3.9. Survey areas that have been cleaned to see if the contamination was removed. Continue cleaning until all contamination is removed.

9.3.10. Survey and change decontamination clothing as needed and frequently (especially gloves).

9.3.11. Remove and replace torn clothing immediately.

9.4. Cautions:

9.4.1. Do not use hot water to clean H-3, C-14, or I-125 because they may vaporize.

9.4.2. Do not use detergents that contain acids to clean iodine spills because reactions may produce toxic gasses.

PROCEDURE 3: SEALED SOURCE LEAK TEST

OAR 333-120-0460

1. SEALED SOURCE INVENTORY

1.1. A list of sealed sources is on file with the RSO.

2. FREQUENCY OF TESTING

2.1. Sealed sources will be tested every 6 months with the following exceptions:

2.1.1. Alpha emitters used for their alpha emissions, which are greater than 10 microcuries (10 μCi, 370 kBq), will be tested every 3 months.

2.1.2. Alpha emitters less than or equal to 10 microcuries (10 μCi, 370 kBq) need not be tested.

2.1.3. Sources containing only gas or tritium need not be tested.

2.1.4. Sources that are in storage and not in use need not be tested. Sources meeting these criteria must be tested prior to being put back in use. Notify the RSO whenever this occurs.

2.1.5. Sources which contain less than or equal to 100 microcuries (100 μCi, 3.7 MBq) of a beta or gamma emitting material need not be tested.

3. PROCEDURE

3.1. The reactor's wipe test procedure, SOP 51, describes how to measure removable radioactive contamination. SOP 51 can be found in the reactor office (Chemistry 102). Take a cotton swab, wipe it on the surface of the source, and count it in a detector. For alpha sources, wipe areas near the source (such as the case) rather than the source itself to prevent damage to the source. Wear disposable gloves when taking wipes.

3.2. A source is considered to be leaking if greater than 185 Bq (0.005 μCi) of contamination is measured.

3.3. As of 2019, the normal wipe test counter is a Perkin-Elmer Tri-Carb 4910 Liquid Scintillation Counter, located in Chemistry 119. If necessary, it is permissible to use a different calibrated detector capable of measuring beta-gamma radiation.

3.4. For alpha wipes, the swab is also counted with a detector capable of detecting alpha radiation, such as a Thermo E-600.

3.5. The wipe test counter is calibrated annually, not to exceed 65 weeks. The wipe test counter is tested for quality control each day a wipe test is performed by measuring a check source and background.

3.6. For information on how to use the Reactor's LSC, see Reed Research Reactor SOP 45.

PROCEDURE 4: USER SURVEYS

1. AMBIENT EXPOSURE RATE SURVEYS

1.1. Conduct surveys with a radiation detection survey meter appropriate for the radionuclide. Record the results of these surveys on Form 2: Radiation Survey Report at least bi-weekly (interval not to exceed 19 days) and whenever unexpected readings occur.

1.2. In storage and waste storage areas: survey at least once a month (interval not to exceed 40 days) with a radiation detection survey meter. Record results on Form 2: Radiation Survey Report.

1.3. In sealed source storage areas: survey at least once a month (interval not to exceed 40 days) with a radiation measurement survey meter. Record results on Form 2: Radiation Survey Report.

1.4. If a higher than expected reading occurs in the survey, and contamination is suspected, a wipe test must be conducted and counted using a detector appropriate for the nuclide to determine if there is removable contamination. Results must be recorded on Form 2: Radiation Survey Report.

2. REMOVABLE CONTAMINATION SURVEYS

2.1. If tritium, carbon-14, or sulfur-35 is used, bi-weekly wipe tests are required (interval between wipe tests not to exceed 19 days). Use the liquid scintillation counter for these tests and record on Form 2: Radiation Survey Report.

2.2. When low energy beta emitting radionuclides are in storage, at least once a month (interval not to exceed 40 days) wipe tests are required. These tests must be counted in a liquid scintillation counter and recorded on Form 2: Radiation Survey Report.

2.3. If higher than expected counts occur in the ambient exposure rate survey (Procedure 4 section A), conduct another wipe test and count using a nuclide-appropriate detector to determine if the contamination is removable. Record results on Form 2: Radiation Survey Report.

2.4. The wipe sample assay procedure should be sufficiently sensitive to detect the presence of 200 dpm/100 cm^2 of removable contamination. A radioactive source with a known amount of activity must be used to convert sample measurements (usually in counts per minute) to microcuries (μCi).

2.5. Records of wipe tests must be retained.

2.6. Wipes of the reactor facility are performed biweekly. Source wipes are performed during routine leak tests. Special wipes are performed during other activities: transportation, contamination events, outside users, etc.

PROCEDURE 5: WASTE DISPOSAL

OAR 333-120-0500, 0520, 0540, 0550, 0560

1. SINK DISPOSAL

1.1. If sink disposal is necessary, permission must be granted by the RSO.

1.2. In consultation with the RSO, procedures for sink disposal will be developed. Rules for disposal in the sanitary sewer appear in OAR 333-120-0520.

2. DISPOSAL BY DECAY IN STORAGE

2.1. Dispose of short-lived material (physical half-life less than 120 days) by decay-in-storage.

2.2. When possible, separate waste by radionuclide so that shorter-lived wastes can be stored only as long as necessary for radiation to decay to background levels.

2.3. Absorb liquids onto vermiculite, clay absorbent, or other material so that no free liquids remain. This reduces the possibility of spills during storage.

2.4. Use plastic double-bags for materials to be decayed-in-storage and seal the bags tightly. Label all materials with the following information (labels are available from the RSO):

- Radionuclide and approximate activity.
- Date.
- Chemical compound(s) contained in the waste and appropriate hazard information.
- Room where the waste was generated.
- Name of person preparing package.

2.5. After packaging decay-in-storage materials, contact the RSO to schedule a waste pick up. Record disposals on Form 3B: Use and Disposal Log. The material will be decayed for at least 10 half-lives. Before release to trash, monitor the material using the appropriate radiation detection device. Wastes must have radioactivity levels that are indistinguishable from background in order to be disposed of in the regular trash. Remove or deface all radioactive materials labels before disposal in the regular trash.

2.6. Prior to disposal, the RSO or designee will label the waste and record the following information on Form 5: Decay-in-Storage Log:

- Activity at time of disposal
- Date.
- Initials of the individual conducting the survey.

3. TRANSFER FOR BURIAL

3.1. Except for material suitable for decay-in-storage and some animal carcasses, transfer solid wastes with a half-life greater than 120 days to a burial site

3.2. Place waste materials in double-bagged and tightly sealed plastic bags. Label the materials with the following information (labels are available from the RSO):

- Radionuclide and approximate activity.
- Date.
- Chemical compound(s) contained in the waste and appropriate hazard information.
- Room where the waste was generated.
- Name of person preparing package.

3.3. After packaging materials for transfer to a disposal site, contact the RSO or Reactor Director to schedule a waste pick up. Record disposals on Form 3B: Use and Disposal Log.

3.4. The RSO or Reactor Director will arrange for disposal at a secure burial site through a commercial waste disposal service and will oversee compliance with all applicable DOT and NRC regulations concerning labeling, packaging, and transportation of radioactive wastes.

PROCEDURE 6: RADIOACTIVE MATERIALS PACKAGE ORDERING & RECEIPT

OAR 333-120-0450; OAR 333-118-0150

1. PROCUREMENT AND AUTHORIZATION

1.1. Radiation Safety Officer (RSO) must approve each request for purchase of radioactive materials before the placement of the order.

1.2. It is the responsibility of the Principal User to obtain RSO authorization to place an order to purchase radioactive materials.

1.3. When the order is placed, the Principal User will notify the mailroom (mail-services@lists.reed.edu) and the RSO of the intended date of receipt. Use Form 3A: Receipt.

2. RECEIPT

2.1. If radioactive material is in excess of Type A quantities, as defined in 10 CFR Part 71.4 the Principal User shall make arrangements to receive the labeled package by contacting the mailroom as mentioned above and by following the steps below:

2.1.1. Upon receipt of packages containing labeled radioactive materials, the mailroom will contact the RSO and the Principal User.

2.1.2. The Principal User will either pick the package up from the mailroom or make specific delivery arrangements with the mailroom.

2.1.3. The Principal User must contact the RSO and provide the following information: radioisotope, chemical form, activity, supplier, and purchase order number

2.1.4. Only the Principal User may open and survey packages of radioactive materials in excess of Type A quantities.

2.1.5. This must be done within three hours of receipt.

2.2. All packages known to contain radioactive materials (whether in excess of Type A or less than Type A quantities) that show evidence of degradation of package integrity, such as packages that are crushed, wet, or damaged must follow procedures outlined in 2.1 above.

3. SURVEY: EXCESS OF TYPE A (EXCLUDING TRITIUM, SULFUR-35, OR CARBON-14)

3.1. Assume any package received is contaminated until thoroughly surveyed.

3.2. The individual receiving the package must wear a dosimetry badge and finger ring. Gloves must be worn over the ring, with the ring's dosimeter on the palm-side of the finger.

3.3. Place the package on absorbent paper in a fume hood. If a fume hood is unavailable and the material is sufficiently low in activity to use outside of a hood, simply place the package on absorbent paper.

3.4. After turning the survey meter ON, measure the radiation level at one meter from the surface of the package.

3.4.1. The reading (in mrem/hr) should agree with the transport index (TI) indicated on the label (e.g., a dose rate of 2.6 mrem/hr is a TI of 2.6).

3.4.2. If the reading is higher, assume the integrity of the package is broken. Record all readings on Form 3A: Receipt.

3.4.3. Use an ion chamber or microR meter for this measurement unless you have a GM meter that is calibrated for use with the particular isotope being measured.

3.5. Move the survey meter far enough away from the package to take a background reading.

3.6. Check gloves with a survey meter. If not contaminated, wipe 300 cm^2 of the package with a tissue or filter paper. A good place to take the wipe is a seal, edge, seam, etc.

3.7. Using a GM meter, survey the wipe by placing it next to the meter probe. If the reading is indistinguishable from background, open the package and wipe the inner container using the same procedure as above. Survey the second wipe using the same procedure. Record all readings on Form 3A: Receipt.

3.8. Deface all radioactive materials labels on uncontaminated packaging before disposal.

3.9. The shipping label gives the amount of material in becquerel (Bq). Make the calculation to determine if this agrees with what was ordered. One Bq equals one disintegration per second. One Curie equals 3.7×10^{10} dps, which is 37 gigabecquerel (GBq).

3.10. If readings greater than 1000 dpm above background are found in any of the above steps, carefully clean the outside of the container before use. Double bag all contaminated material for disposal as radioactive waste. Inform the RSO.

4. SURVEY FOR TRITIUM, SULFUR-35. OR CARBON-14: EXCESS OF TYPE A

4.1. Assume any package received is contaminated until thoroughly surveyed.

4.2. Don protective gloves and safety glasses.

4.3. Place the package on absorbent paper in a fume hood. If a fume hood is unavailable and the material is sufficiently low in activity to use outside of a hood, simply place the package on absorbent paper.

4.4. Perform a wipe of 300 cm^2 on the outside of the package. Analyze using a liquid scintillation counter (LSC). Record all readings on Form 3: Receipt.

4.5. If no contamination is found on the outside of the package, open the package and perform a wipe test on the inside of the package and on the container. Analyze using a LSC. Record all readings on Form 3A: Receipt.

4.6. Deface all radioactive materials labels on uncontaminated packaging before disposal.

4.7. If readings greater than 1000 dpm above background are found in any of the above steps, carefully clean the outside of the container before use. Double bag all contaminated material for disposal as radioactive waste. Inform the RSO.

PROCEDURE 7: CLOSE-OUT AND DECOMMISSIONING

OAR 333-102-0310

1. CLOSE OUT PROCESS

1.1. The RSO or designee will carry out the close-out process in areas where radioactive material will no longer be used.

1.2. Close-Out Survey:

1.2.1. Thoroughly survey the laboratory using a GM meter if appropriate. Use Form 2: Radiation Survey Report to record findings.

1.2.2. Perform a survey and/or wipe tests of equipment, to determine if removable contamination is present. Analyze using a liquid scintillation counter or other appropriate counting equipment.

1.2.3. Perform a wipe test of the sink drainpipe and/or floor drain if there is one. Use tongs or other devices to ensure that the wipe sample is taken from fairly deep within the drain.

1.2.4. Perform a survey and/or wipe test in adjacent laboratories/rooms and equipment to check for spread of contamination or unauthorized use.

1.3. Waste Removal:

1.3.1. Use Form 3B: Use and Disposal Log to balance the radioactive materials inventory for the lab.

1.3.2. Dispose of all waste materials in accordance with Procedure 5: Radioactive Waste Disposal Procedures.

1.4. If any contamination is found, thoroughly clean the area and retest. Repeat until the laboratory is free of contamination.

1.5. When all radioactive materials and waste have been removed from the lab and surveys indicate that no contamination is present, remove all radioactive materials labels from the laboratory door, equipment, and workbenches.

1.6. The Principal User will forward final records of any laboratory decontamination, radioactive materials disposal, and inventory balance to the RSO. The RSO will inspect the lab and send a memo to the Principal User and the chair of the Radiation Safety Committee documenting that the lab is closed out.

2. DECOMMISSIONING PROCESS

2.1. The RSO or designee will provide a decommissioning plan pursuant to OAR 333-102-0310 before license termination that includes the following:

2.1.1. Description of the site.

2.1.2. Planned decommissioning activities including levels of risk and safety concerns.

2.1.3. Methods used to protect workers and the environment from radiation during decommissioning.

2.1.4. Description of planned final radiation survey.

2.1.5. Estimate of costs and plan for ensuring availability of funds.

2.2. The RSO or designee will certify the disposition of all licensed materials by submitting NRC Form 314 or an equivalent.

2.3. Decommissioning must be completed and license termination requested as soon as practicable and within 24 months after decommissioning begins.

2.4. Survey:

2.4.1. Carry out a final survey of the places where licensed materials were used.

2.4.2. Submit a report that includes levels of gamma radiation per hour at one meter from surfaces; levels of radioactivity (alpha, beta, and gamma) per 100 square centimeters on surfaces, per milliliter in water, and per gram for solids; and survey instruments used.

2.5. Records to be forwarded to the Oregon Health Authority before license termination.

2.5.1. Records of disposal of licensed material (OAR 333-102-0355).

2.5.2. Records of the results of measurements and calculations used to evaluate the release of radioactive effluents to the environment (OAR 333-120-0620(2)(d)).

PROCEDURE 8: PERSONNEL TRAINING

1. PRINCIPAL USERS

1.1. Principal Users (training outlined on in Policy 13.b) are typically faculty or staff who supervise a lab using radioactive materials, such as Faculty, Researchers, the Reactor Director, the Reactor Operations Manager, the Radiation Safety Officer, or the Assistant Radiation Safety Officer.

1.2. Principal Users must pass (80%) the examination under the same conditions as Authorized Users (below).

1.3. All new Principal Users will be supplied with a copy of the Reed College Radioactive Materials Policy and Procedures Manual, the Reed College Radioactive Materials Handling Study Guide, and a copy of the U.S. Nuclear Regulatory commission Regulatory Guide 8.13, Instruction Concerning Prenatal Radiation Exposure.

1.4. If the Principal User has documentation of training and use of radioactive materials at another institution, no further training is required. If no such documentation exists, the Principal User must follow the procedure for new Authorized Users (below) to become authorized.

1.5. The Principal User must complete Form 8: Application for Use of Radioactive Materials and submit it to the Radiation Safety Committee for approval before radioactive materials may be used in the laboratory.

1.6. The Principal User must renew his/her Application for Use of Radioactive Materials every three years. If the procedure for use has not changed significantly, the Principal User can review his/her present application and resubmit it for review by the Radiation Safety Committee.

1.7. Any significant changes in procedures require the Principal User to submit a new application for approval by the committee.

2. AUTHORIZED USERS

2.1. Authorized Users may be students, non-Reed employees, visitors, or others who use radioactive materials under the direction of a Principal User. Minors (<18 years of age) are not permitted to work with radioactive materials.

2.2. All new Authorized Users must take and pass (80%) a radioactive materials authorization examination provided by the RSO. The Authorized User trainee may only take the test three times without further committee approval. There must be a period of five days between the first and second attempt and a period of ten days between the second and third attempt of the test. The Radiation Safety Committee must approve further attempts at the test.

2.3. All new Authorized Users must be assigned to work with a Principal User.

2.4. Before the Authorized User may begin work with radioactive materials, the Principal User will train the Authorized User to use a scintillation counter (if applicable) and/or in safe laboratory use of radioactive materials. Before the Authorized User's authorization is complete, a signed Certificate of Authorized User Training (Form 7) must be received by the RSO.

2.5. Authorized User trainees must watch three video tapes (QC41.R33 1982 VIDEO, located in the Reed College IMC; or equivalent radiation safety videos) before taking the authorization examination. The video tapes pertain to Principles of Radiation, Laboratory Safety, and Emergency Procedures.

2.6. The Authorized User trainee will receive a copy of the Reed College Radioactive Materials Policy and Procedures Manual and a Radioactive Materials Handling Study Guide to prepare for the examination.

3. ANCILLARY PERSONNEL

3.1. Those employees whose duties may bring them in the vicinity of radioactive materials (e.g., security, maintenance, and custodial personnel) will receive training triennially in the following topics as part of their Right-To-Know training:

3.1.1. Locations where radioactive materials are stored.

3.1.2. Overview of the *Reed College Radioactive Materials Policy and Procedures Manual* as it pertains to the survey and wipe testing of work areas.

3.1.3. Procedures for entry into areas where radioactive materials are used.

3.1.4. Recognition of radioactive materials labels.

3.2. REFRESHER TRAINING

3.2.1. A triennial overview (interval not to exceed 156 weeks) of the Reed College Radioactive Materials Policy and Procedures manual will be presented to all active Principal Users, and Authorized Users outside of the Reactor Training Program.

3.2.2. This overview will require a retest. Inactive Principal Users will receive refresher training and retesting before resuming use of radioactive materials.

3.2.3. Authorized Users within the Reactor Training Program will receive continuous training on health physics and radiation safety as part of their licensing process, which includes homework/testing.

3.2.4. All users will receive refresher training whenever significant changes to duties, rules, or the terms of the license occur.

APPENDIX A: OCCUPATIONAL AND PUBLIC RADIATION DOSE LIMITS [3] [4]

	State of Oregon Radiation Protection Services (OAR 333-120-0100)	Oregon OSHA [5] (29 CFR 1910.1096)	American Conference of Governmental Industrial Hygienists (ACGIH)	Department of Energy (DOE)	Nuclear Regulatory Commission [6] (NRC)	International Atomic Energy Commission (IAEA)	International Commission on Radiological Protection (ICRP) (2010)
Occupational							
Whole body (deterministic) [7]	5,000 mrem per year	1,250 mrem per quarter for the whole body (head and trunk; active blood-forming organs or gonads)	2,000 mrem per year average over 5 years (10,000 mrem in 5 years), not to exceed 5,000 mrem in any single year	5,000 mrem per year	5,000 mrem per year	2,000 mrem per year average over 5 years (10,000 mrem in 5 years), not to exceed 5,000 mrem in any single year	2,000 mrem per year average over 5 years (10,000 mrem in 5 years), not to exceed 5,000 mrem in any single year
Lens of eye	15,000 mrem per year	1,250 mrem per quarter	15,000 mrem per year	15,000 mrem per year	15,000 mrem per year	15,000 mrem per year	5,000 mrem per year
Hands, forearms; feet and ankles	50,000 mrem per year	18,750 mrem per quarter	50,000 mrem per year	50,000 mrem per year	50,000 mrem per year	50,000 mrem per year	50,000 mrem per year
Skin	50,000 mrem per year	7,500 mrem per quarter	50,000 mrem per year	50,000 mrem per year	50,000 mrem per year	50,000 mrem per year	50,000 mrem per year
Embryo-fetus of pregnant worker [8]	500 mrem per gestation period	No limit established	50 mrem per month over gestation period	500 mrem per gestation period	500 mrem per gestation period	No limit established	100 mrem per gestation period

[3] Table based, in part, on NIOSH Health Hazard Evaluation Report 2003-0206-3067

[4] The dose limits are reported in the conventional units (mrem) to be consistent with the U.S. regulations.

[5] OSHA occupational dose limits are reported in terms of dose equivalent per calendar quarter and apply only to individuals who work in a restricted area. Restricted area means any area that is controlled by the employer for purposes of protecting individuals from exposure to radiation or radioactive materials. Minors are restricted to 10% of the limits shown.

[6] NRC states that if members of the public are continuously present in an unrestricted area, the dose from external sources cannot exceed 0.002 rem in an hour and 0.05 rem in a year.

[7] Occupational and public deterministic dose limits (except OSHA) are reported in terms of annual effective dose (E); the cumulative dose limit is a cumulative effective dose limit. The effective dose (E=wRHT) is intended to provide a means for handling non-uniform irradiation situations. The tissue-weighting factor (wR) takes into account the relative detriment to each organ and tissue including the different mortality and morbidity risks from cancer. In other words, the risks for all stochastic effects will be the same whether the whole body is irradiated uniformly or not.

[8] Embryo-fetus dose limit is an equivalent dose (Hg. T) limit in a month once pregnancy is known. The equivalent dose limit is based on an average absorbed dose in the tissue or organ (DT) and weighted by the radiation weighting factor (wR) for radiation impinging on the body (HT=wR DT).

APPENDIX B: Acceptable Surface Contamination Levels

Nuclide[a]	Removable [b,e,f] (dpm/100 cm^2)	Average [b,c,f] (dpm/100 cm^2)	Maximum [b,d,f] (dpm/100 cm^2)
U_{Nat}, U-235, U-238, and associated decay products	1000 α	5000 α	15000 α
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, and I-129	20	100	300
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-133, and I-131	200	1000	3000
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above	1000 $\beta\gamma$	5000 $\beta\gamma$	15000 $\beta\gamma$

[a] Where surface contamination by both alpha and beta-gamma emitting nuclide exists, the limits established for alpha and beta-gamma emitting nuclide should apply independently.
[b] As used in this table, dpm means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.
[c] Measurements of average contaminant should not be averaged over more than 1 m^2. For objects of less surface area, the average should be derived for each such object.
[d] The maximum contamination level applies to an area of not more than 100 cm^2.
[e] The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.
[f] The average and maximum radiation levels associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 millirad per hour (mrad/hr) at 1 cm and 1.0 mrad/hr at 1 cm, respectively, measured through not more than 7 mg/cm^2 total absorber. The external gamma exposure rate should not exceed 5 microroentgen per hour above background at 1 meter from the surface and for soil 10 microroentgen per hour, above background at 1 meter.