Radiation Safety Manual

Emergency Contacts and Telephone Numbers

Environmental Health & Safety Department	303-871-4044
Emergency/ Security	1-3000

The EH&S Department is located in the Administrative Office Building, 2nd Floor. The telephone is 303-871-4044/7501. The hours of operation are 7:00 a.m. to 4:30 p.m., M-F. For after-hours emergencies, call 303-871-3000.

Introduction

University of Denver (DU) has been issued a license to purchase, use, and dispose of radioactive material. This license was granted by the Colorado Department of Public Health and Environment (CDPHE) in agreement with the regulations of the U.S. Nuclear Regulatory Commission (NRC). Colorado is an "Agreement State," whereby CDPHE adopted the regulations of the NRC and is thereby given the authority to govern the use of radioactive materials within the State of Colorado.

This manual was developed to aid each laboratory in proper procedures when working in a radioisotope laboratory. Each required form is attached, as well as instructions for their use.

Personal Monitoring

Dosimeters

All laboratories that display the radioactive materials symbol are classified as "restricted areas." Personnel working with detectable radiation shall wear a radiation dosimeter. This device should be worn between the hip and shoulder level outside of clothing. In addition, all laboratory personnel who handle more than 2 mCi of P-32 are required to wear a ring dosimeter. Finger ring dosimeters shall be worn on the hand most likely to receive the highest exposure. Rings are worn with the name facing the palm, inside any protective gloves. Dosimeters shall be turned in to the RSO by the 10th of the month succeeding the wear date. Dosimeters are sent off-site for processing. Reports are then sent to each lab, and a copy is kept on file by the RSO.

Prior to hiring a new laboratory worker, the lab should contact the RSO. They may need to complete and submit a **Radiation Exposure History** form (App. 1) to the RSO as soon as possible. Regardless of whether or not the new employee has ever worn a dosimeter at another facility, this form must be completed and signed. Regulations require a signed release in order to obtain exposure records from previous employers.

Bioassays

Anyone working in a laboratory that uses radioiodine must have a baseline bioassay reading **prior** to start of employment. If you intend to work with unbound Iodine, call the RSO to arrange use of the hot lab fume hood, and a thyroid scan. Any researcher who is working with greater than 10 mCi of radioiodine is required by regulation to have a thyroid bioassay. Accidental exposures to radioiodine of greater than 10 mCi must be evaluated within 72 hours of exposure. Follow up bioassay readings will be taken every

two weeks until thyroid levels have normalized. Continued high readings may necessitate changes in laboratory procedures.

ALARA (As Low As Reasonably Achievable) Program

The potential adverse health effects of low-level radiation exposure, specifically, an increased risk of carcinogenesis and/or genetic defects in future generations, are considered to be non-threshold phenomena. Limits have been established regarding occupational radiation exposure. This is known as an Occupational Dose Limit. The risk of radiation exposure less than the occupational dose limit decreases with magnitude of exposure and is considered to be very small, but NOT nonexistent. It is the policy of DU that all exposures must be justified, and that they must be maintained ALARA. These considerations define the rationale for maintaining radiation exposures ALARA, i.e. to avoid any unnecessary risk, no matter how small.

Listed below are the limits regarding Occupational Radiation Exposure according to the **Colorado Department of Public Health and Environment, Radiation Control Division**. These exposure limits are separated according to tissue sensitivity.

Total Effective Dose	5 Rem/year
Eye Dose	15 Rem/year
Individual Organ Dose	50 Rem/year
Shallow Dose	50 Rem/year
Public Dose	100 mRem/year
Dose to Embryo/Fetus	500 mRem/Gestation Period

University of Denver ALARA Program

Since radiation exposure levels at DU are very low, our ALARA program utilizes lower values at which action is taken. These numbers are per year and are separated by tissue sensitivity. There are two Exposure Levels, Level I corresponding to 2.5%, and Level II corresponding to 8% of the annual occupational dose limit. The appropriate action is also indicated for each level.

	Level I	Level II
Total Effective Dose:	125 mRem	410 mRem
Eye Dose:	375 mRem	1200 mRem

Individual Organ Dose:	1250 mRem	1250 mRem
Shallow Dose:	1250 mRem	1250 mRem

Exposures are per monitoring period (Quarterly)

Actions Taken:

I. Less than Level I:
No further action unless deemed necessary by the Radiation Safety Officer. If an observed reading is consistently higher than other members of the same restricted area, or an exposure of a radiation type not found in that restricted area, there may be an informal investigation.

II. Equal to or greater than Level I but less than Level II:
Notification of employee and the Principal Investigator/Department Manager by the Radiation Safety Officer or their designee.

III. Equal to or greater than Level II:
There will be an investigation and report to the RSO.

Declared Pregnant Women

I. Procedure

In keeping with the recommendations of the National Council for Radiation Protection, it is the policy of DU to limit the radiation exposure of every Declared Pregnant Employee to 500 mRem for the duration of the pregnancy. The provisions of this policy only cover those employees who voluntarily declare their pregnancy.

II. Definition

Declared Pregnant Woman means a woman who has voluntarily informed her employer, in writing, of her pregnancy and the estimated date of conception. At DU, that notification must include the Radiation Safety Officer (RSO).

III. Procedures

A. Contact the Radiation Safety Officer at the earliest suspicion of pregnancy. Every effort will be made to keep privacy information confidential.

B. Complete the **Declaration of Pregnancy** form (App. 2) including the signature and estimated date of conception.

C. The supervisor and/or the Radiation Safety Officer will review the hazards of radiation with the employee. Whenever possible, the employee will be moved to a position involving the least radiation hazard.

D. A pregnancy radiation dosimeter will be assigned. This dosimeter should be worn at waist level. Contact the RSO with questions.

E. A copy of the memo regarding any additional necessary precautions to assure minimum radiation exposure will be sent to the employee's manager and personnel records.

Procedures for Accidental Release of Radioactive Materials

In case of a spill of radioactive materials, follow the protocol below:

1. Address any medical condition first. Injuries take priority over clean-up.

2. DO NOT use Radiac Wash, Lift Away, Count-off, etc. on cuts or punctures. Radiac Wash can be used on the skin if there are no breaks in the skin surface. Wash with soap and water.

The activity levels below are guidelines only. If it is felt that it may endanger personnel by attempting the cleanup, notify the RSO immediately.

I. Minor Spills (< 100 uCi)

A. Notify person(s) in the area about spill.
B. Using disposable gloves, cover the spill with absorbent paper. Fold absorbent paper and insert into a plastic bag. Change gloves often to prevent the spread of contamination. Place all possible contaminated material into plastic bag. Area can be cleaned using a radioactive detergent such as Radiac Wash, Lift Away, or Count-Off.
C. Survey area and yourself using an appropriate survey meter. Area wipe tests must be done to document that area has been decontaminated.
D. Contact the RSO to report the incident as soon as possible.

II. Major Spills (> 100 uCi)

A. Contact the RSO immediately.

B. Cover the spill with absorbent paper, but **DO NOT CLEAN UP**.

C. Prevent persons from entering the area. Leave the room and lock all doors to prevent entry.

D. In the event that someone has come in contact with radioactive material, remove contaminated clothing and place in a secured area. If the spill is on the individual's skin, flush with water and wash with soap and lukewarm water. **DO NOT** use a brush to abrade the skin, this will increase circulation to the area and may hasten absorption of the radioactive material.

E. Wait for the RSO to arrive.

F. In an emergency, contact the Emergency Operator at 1-3000.

G. G. Fill out **Hazardous Materials Incident Report**, (App. 3), submit to RSO .

Training

The Principal Investigator of each laboratory that uses radionuclides **must** become a certified user. No radioactive materials may be received without the approval/signature of a certified user. Contact the RSO for information regarding this process. All researchers that work in laboratories classified as "restricted areas," shall attend initial/refresher radiation safety training. This training will consist of general radiation principles and definitions, radiation protection practices, and State or Colorado regulations as well as DU radiation safety practices. In addition, researchers must pass the Radiation Safety for Occupational Workers examination.

Purchasing Radioactive Materials

All purchases of radioactive materials must be approved by the Radiation Safety Officer. This is to ensure that only certified users are purchasing radionuclides and that the limits of the University of Denver license are not violated.

I. The laboratory submits the Request for radionuclides to the RSO. The information required is as follows:

   A. RAM must only be requested by a Certified Principal Investigator.

II. Upon approval, the request will be signed by the RSO.

If a lab wishes to order a radionuclide that they have not been previously approved for, they will need to complete the **Application for Radionuclide Use** form, (App.5), and submit it to the RSO. If the radionuclide is not on the DU License, an amendment will need to be submitted to CDPHE for the proposed addition. This may take some time, so plan accordingly.

All radioactive material will be tracked by the using lab, and the RSO in order to adhere to the policies of the NRC, CDPHE, and DU.

Receiving Radioactive Materials

1. All orders for radioactive materials must be pre-approved by the Radiation Safety Officer (RSO). The Radiation Safety officer, (RSO), will monitor all radioactive materials packages received at DU, in accordance with RH 4.32. *Packages will be received at the Engineering and Computer Science (ECS) Building, at 2155 E. Wesley Ave, Denver, CO 80208. Room 122A, (see attached diagram), which will serve as the "storage room" for safe-keeping until delivery. The previous receiving location was at 2467 S. Vine St, which is no longer used.*

2. ECS 122A is a card-access room, and any radioactive material would be temporarily stored in a lockable cabinet. Lead bricks are available for shielding when necessary.

3. The "Notice to Employees", emergency phone numbers, and required warning signage will be posted on the door of 122A. Public Dose surveys will be performed for the area in

conjunction with our standard dosimetry schedule. Monthly contamination surveys will be conducted for the room.

4. The RSO will perform the monitoring required by 6 CCR 1007-1 4.32.2 as soon as practical after receipt of the package, but not later than 3 hours after the package is received at DU's facility if it is received during normal working hours, (M-F, 07:30-16:00), or not later than 3 hours from the beginning of the next working day if it is received after working hours.

   A. Packages needing to be surveyed for exterior surface contamination will be swipe tested. Non-fixed (removable) contamination shall be based upon wiping an area of 300 square centimeters of the surface concerned with an absorbent material, using moderate pressure, and measuring the activity on the wiping material. Swipe samples will be assayed on a liquid scintillation counter, (or Ludlum Alpha/Beta counter).

Non-Fixed External Radioactive Contamination Limits for Packages

Contaminant	Maximum permissible limits		
	Bq/cm ^{2}	uCi/cm ^{2}	dpm/cm ^{2}
1. Beta and gamma emitters and low toxicity alpha emitters	4	10^{-4}	240
2. All other alpha emitting radionuclides	0.4	10^{-5}	24

   B. Packages needing to be surveyed for exterior radiation levels will be scanned with a calibrated Ludlum survey meter per guidelines in 6 CCR 1007-1 17.15.

   C. Packages deemed to be uncontaminated, per the regulations, will be delivered by the RSO to the lab.

   D. The RSO will immediately notify the carrier and CDPHE by telephone, when removable radioactive surface contamination exceeds the limits of 17.15.8 of the regulations; or, external radiation levels exceed the limits of 17.15.9 and 17.15.10 of the regulations.

5. To open a radioactive material package, the lab worker shall first don appropriate PPE, (lab coat, gloves, safety glasses, etc.). In order to take receipt of any radioactive packages, the researcher may need to be wearing a dosimeter. A ring badge is also required for packages containing more than 2 mCi of P-32.

6. A form titled "Radioisotope Usage Form" will be attached to each package. The Radioisotope Usage Form must be used as an inventory form in the laboratory, and, must be updated with each use and/or disposal of radioactive material.

7. While it is the responsibility of the RSO to maintain records of purchase and disposal, it is the responsibility of each Principal Investigator to maintain records of current levels of radioactive material in the laboratory. Transfer of radioactive material between labs is not allowed without prior authorization of the RSO.

8. A member of the laboratory who is a certified/trained worker will be required to sign for the package. The laboratory retains a copy of the "Radioisotope Usage Form" for recordkeeping purposes. This form is also used in the waste disposal tracking process. If a certified worker is not available to accept the package, it will be placed in storage until the laboratory can make arrangements to pick up the package. If the laboratory fails to follow this procedure, the RSO will treat the package as unclaimed. Any type of paperwork discrepancies should be reported to the RSO as soon as possible. If a package arrives at the laboratory without a Radioisotope Usage Form, contact the RSO so that one may be generated.

If a package is expected for weekend delivery, prior arrangements must be made with the RSO. Security will not accept packages containing radionuclides.

Radioactive Material Disposal

All radionuclides, unless injected into an animal, will be disposed of via arranged processes with the RSO.

I. Things to Remember

A. A copy of the Radioisotope Usage Form, indicating the total decayed amount of activity being disposed of on the day of the pickup must accompany all waste to be collected, with a separate copy for each type of disposal, i.e. solid, liquid, or vial.

B. Solid waste and vials must be separated and placed in clear, 4 mil plastic bags. Biohazard bags or waste basket liners will not be accepted.

C. Each bag or container must be segregated by radionuclide and labeled accordingly, including the name of the laboratory generating the waste.

D. For liquid waste pickups, the concentration (in **percent**) and **full chemical name** of the ingredients must be listed on the Radioisotope Usage Form. For example, 10% methanol, 20% chloroform, 70% water. For solid ingredients, indicate approximate percent by weight.

E. Solid waste must contain < 0.1% liquid.

F. All radioactive symbols must be defaced. **Defacing Boxes That Have Radioactive Markings:** According to CDPHE regulation RH4.30.2, all boxes that have radioactive markings must be defaced such that the markings cannot be distinguished. This can be accomplished by using a black marker or tearing the labels off of the boxes.

If there are any questions regarding these procedures, please contact the RSO at extension 1-4044. Failure to follow these guidelines will result in delays in collection of radioactive waste.

II. **Sink Disposal**

Any sink disposal requires **PRIOR** approval of the RSO. Any disposal via the sewage system will be in accordance with the monthly average concentration limits established in RH 4, Appendix B, Table III, and RH4.35. All materials disposed in this manner must be readily soluble in water or readily dispersible biological material in water.

Each laboratory must maintain a monthly **Sink Log** (App. 5) to track radioactive materials that enter the sanitary sewer waste stream.

Laboratory Contamination Surveys

All restricted areas must be surveyed monthly for radioactive contamination. Once a laboratory is classified as a radionuclide laboratory, a floor plan of the laboratory must be submitted to the RSO. This map will indicate areas where radiation is used and stored. On this map shall be listed the areas that will be wipe tested monthly. Each area wipe shall be performed on an area of approximately 100 cm^2, (4" x 4"). Surveys are analyzed using a liquid scintillation counter (LSC) or gamma counter, and must indicate the type of radiation being surveyed. All survey reports must include the printed sheet from the device used, indicating a background reading and the actual counts obtained for each area. Survey locations must correspond to the map submitted to the RSO. If survey results indicate a contamination equal to or greater than **three** times background, the laboratory representative must decontaminate the area, re-survey, and provide the results to the RSO. If survey results are consistently high (over a three month period), the RSO will conduct an investigation to determine how exposures can be maintained ALARA.

The form titled **Monthly Radiation Survey** (App. 6) is used for area survey reports. This form must be available for review by the RSO.

Failure to comply with this policy will result in the following action(s) by the RSO:

1st Violation: The laboratories radioactive material purchasing privileges will be immediately suspended until the required documentation is received in the RSO.

2nd Violation: Within one year of the 1st violation, radionuclide use within the laboratory may be suspended. Reinstatement of these privileges will be at the discretion of the Radiation Safety Officer.

Paperwork delays due to unexpected illness or other emergencies should be reported to the RSO as soon as possible by the Principal Investigator or Laboratory Safety Representative. Planned delays, such as vacations, need to be reported to the RSO ***prior*** to the 10th of the month by the Laboratory Safety Representative.

Moving/Removing Used Laboratory Equipment

Large laboratory equipment used in isotope work that is either scheduled to be moved by Environmental Services, or serviced by an outside contractor, MUST be properly decontaminated prior to being moved and/or serviced. The **Decontamination of Research Equipment Form** , (App. 7), must be completed by the person performing the

decontamination,and signed by the Principal Investigator. Wipe test results are required for beta and/or gamma contamination depending on the material used in the equipment. The RSO will then verify that the equipment has been properly decontaminated, and will inform the appropriate parties.

Radiation Survey Meters

For labs that possess radioactive materials capable of being detected by handheld devices, they must obtain a survey meter. In order to ensure that all survey meters are calibrated annually. All survey meters are placed into a regular/annual calibration cycle.

Security of Radioactive Materials

Security of all licensed or registered sources of radiation to prevent unauthorized removal shall be in accordance with RH 4.25 and RH 4.26. This means that all stock vials will be secured when not in use, and that lab doors locked when the lab is unoccupied. All radionuclide research labs are to be considered "Restricted Areas" for the purposes of preventing unauthorized access and unnecessary radiation exposure.

Transportation of Radioactive Material

Requirements for the transportation of radioactive materials to other institutions must comply with both CDPHE and Department of Transportation regulations. The RSO must be notified before any shipments occur.

Laboratory Audits

Unannounced audits will be conducted annually in each radioactive materials laboratory. These audits will be completed to ensure that all laboratories comply with DU policies and procedures, and all Federal, State, and Local regulations.

Eating or drinking in the laboratory is permitted **ONLY** in areas that have been designated and approved by the RSO. Consumption/storage of food or beverages is **NOT permitted** in non-designated laboratory areas or in refrigerators or freezers containing radioactive and/or other hazardous material. This policy will be strictly enforced.

Appendix 1

Radiation Exposure History

The EH&S Department maintains the previous exposure histories of current employees. (As required by the Colorado Department of Public Health and Environment, RH 4.10 and 4.44. You must sign and date this form.

Participant #: _____ Spare Dosimeter #: _____

Index #: _____ Spare Ring Dosimeter #: _____

PLEASE PRINT LEGIBLY

Name: _____ Birthdate (MM/DD/YYYY): _____

Dept./Lab: _____ P.I.:_____

I authorize the release of my radiation exposure records to the University of Denver EH&S Department, Denver, Colorado.

Signature: _____ Date: _____

Fill in this section ONLY if you have worn a dosimeter before.

Previous Institution:
_____

Previous Institution's Address:_____

City: _____ State (Country): _____ Postal Code: _____

Contact Person: _____

Dates Worked: From ____/____/____ To ____/____/____

Previous Institution:
_____

Previous Institution's Address:_____

City: _____ State (Country): _____ Postal Code: _____

Contact Person: _____

Dates Worked: From ____/____/____ To ____/____/____

Previous Institution:
_____

Previous Institution's
Address:_____

City: _____ State (Country): _____ Postal Code:
_____

Contact Person: _____

Dates Worked: From ____/____/____ To ____/____/____

Appendix 2

DECLARATION OF PREGNANCY

Name of Individual _____

Lab _____

Approximate Conception Date _____

Estimated Due Date _____

By providing this information, I am declaring myself to be pregnant as of the date shown above. Under the provisions of RH 4.13 "Dose to Embryo/Fetus", I understand that my exposure will not be allowed to exceed 500 mRem during the entire pregnancy from occupational exposure to radiation. I understand this limit includes exposure that I have already received. If my estimated exposure since the above date of conception has already exceeded 450 mRem, I understand that I will be limited to no more than 50 mRem for the remainder of the pregnancy. When the pregnancy has ended I will inform my supervisor and the Radiation Safety Officer, (RSO), as soon as is practical. I also understand that I have the right to revoke the declaration at any time and that such revocation must be made in writing to the RSO.

Radionuclides/radiation producing machines:
I will be working with these radionuclides/activity levels:

_____

Signature _____

Date Signed _____

Name of Supervisor _____

I have received notification from the above named individual that she is pregnant. I have explained to her the potential risks from exposure to radiation. I have evaluated her prior occupational exposure, and have established appropriate measures to control the dose to embryo/fetus in accordance with the limits in RH 4.13. I have explained to her options for reducing her exposure to as low as reasonably achievable, (ALARA).

Signature of Supervisor _____

Date _____

Please forward this completed form to the Radiation Safety Officer, AOB, Fax 303-871-4097.

Appendix 3

Hazardous Materials Incident Form

Date: _____ Location: _____

Describe Incident: _____

_____

_____

Chemicals/Radionuclides Involved: _____

Persons Contaminated/Injured:

_____

Injury(s): _____

Medical Actions Taken:

_____

_____

Wipe Test Results

Vial #1	Vial #2	Vial #3
beta_____dpm	beta_____dpm	beta_____dpm
gamma _____dpm	gamma_____dpm	gamma_____dpm
Background _____dpm		

Actions Taken To Prevent
Recurrence_____

_____

_____

_____

Comments:

_____

_____

Appendix 4

Application for Radionuclide Use Authorization Form

Name: _____ Ext.: _____

Lab: _____ Date: _____

Only radionuclides that are on your laboratory's license may be ordered by the laboratory.

Radionuclide	Chemical and/or Physical form	Activity (mCi) of each order	Frequency of Purchase

Principal Investigator

Signature _____ Date: _____

Radiation Safety Officer Approval

Signature _____ Date: _____

Appendix 5

Master Sink Disposal Log

Date	Radioisotope	Activity Disposed	Technician

Appendix 6

Monthly Survey Form – Month/Year _____

Wipe Test Location	Pass/Fail	Wipe Test Location	Pass/Fail

Appendix 7

Decontamination of Research Equipment Form

Please fill out completely and return to the EH&S Office. Please allow sufficient time. Moving large pieces of equipment may require an outside contractor. All equipment must be decontaminated and checked by the RSO prior to being serviced or moved.

Principal Investigator: _____ Date: _____

Ext.: _____ Building: _____ Room: _____

Type of Equipment: _____

Person doing Decontamination: _____

Please check all that apply for: Equipment was used

- o Biological work
- o Chemical work
- o Radioactive work
- o Equipment was not used for any of the above.

To decontaminate equipment, REMOVE ALL CHEMICALS FROM THE EQUIPMENT. This is to prevent accidental spills or contamination problems.

Chemical work:

- Wipe the piece of equipment with an appropriate cleaning agent.
- If possible, let "air" overnight.

Biological work:

- Wipe the entire piece of equipment with a 10% bleach solution.
- If possible, let "air" overnight

Radioactive work:

- Wipe down the piece of equipment with an appropriate radioactive material decon solution.
- External surfaces of equipment must have a wipe test done prior to being worked on or moved. Any equipment that is being disposed of must have the internal surfaces checked as well. Wipe test results are required for beta and/or gamma contamination, depending on the material used in the equipment. Attach scintillation counts printout to this form.

All applicable utilities, (gas, water, etc.) have been disconnected? o Yes o No

I certify that a trained employee has properly decontaminated this piece of equipment.

Principal Investigator _____ **Date:** _____

Below to be completed by the EH&S Department

Verified by: _____ **Date:** _____

O Passed O Failed Date Sent to Next Department: _____