



# **Radiation Safety Manual**

University of Denver

Department of Environmental Health & Safety

3<sup>rd</sup> Edition. August 2024

*This page intentionally left blank*

## Introduction

The University of Denver has been issued a license, numbered CO 108-05, for possession and use of radioactive material for research and development from the State of Colorado; this license does not authorize commercial distribution. The University of Denver's Radioactive Materials License is unspecified, however is similar to the requirements of a "Type C specific license of broad scope" due to the small quantity of radioisotopes currently in use. This license has been specifically issued by the Colorado Department of Public Health and Environment (CDPHE) in agreement with the regulations of the United States Nuclear Regulatory Commission (NRC); the regulations of the CDPHE may be more stringent than the NRC. The State of Colorado is an "Agreement State," in which the CDPHE has adopted the regulations of the NRC and is therefore granted the authority to govern the use and disposal of radioactive materials within the State of Colorado.

This safety manual has been developed to aid laboratories at the University of Denver in the proper procedures when working with radioisotopes. Required forms and instructions for their use can be found in the appendices of this manual.

# Table of Contents

Emergency Contacts and Telephone Numbers.....	1
Department of Environmental Health & Safety .....	1
Authorized Radioactive Materials .....	2
Requirements of the University .....	3
General Provisions (Part 1).....	3
Licensing of Radioactive Material (Part 3).....	3
General Requirements of Specific Licenses.....	4
Type A Specific License of Broad Scope.....	4
Type B Specific License of Broad Scope .....	5
Type C Specific License of Broad Scope .....	6
Unity.....	6
Timely Decommissioning .....	7
Standards for Protection Against Radiation (Part 4).....	8
Notices, Instructions and Reports to Workers: Inspections (Part 10).....	8
Transportation of Radioactive Material (Part 17) .....	8
Personal Monitoring .....	8
Dosimeters.....	8
Bioassays .....	9
As Low As Reasonably Achievable (ALARA).....	10
University of Denver ALARA Program.....	10
Total Effective Dose .....	11

Eye Dose.....	11
Individual Organ Dose.....	11
Shallow Dose .....	11
University of Denver Response Actions .....	12
Declared Pregnant Woman .....	12
Definition .....	13
Procedures.....	13
Accidental Release of Radioactive Materials.....	13
Minor Spills (< 100 µCi) .....	13
Major Spills (> 100 µCi) .....	14
Training .....	14
Procuring Radioactive Materials.....	15
Tracking Radioactive Material .....	15
Receiving Radioactive Materials.....	15
Non-Fixed External Radioactive Contamination Limits for Packages.....	16
Radioactive Material Disposal .....	18
Solid Waste Disposal .....	18
Liquid Waste Disposal.....	18
Sink Disposal.....	18
Defacing Shipping Containers.....	19
Laboratory Contamination Surveys .....	19
Moving or Decommissioning Radioactive Instruments .....	20
Radiation Survey Meters.....	21

Security of Radioactive Materials .....	21
Transportation of Radioactive Material .....	21
Laboratory Audits .....	22
References .....	I
Appendix A: Radiation Exposure History .....	II
Appendix B: Declaration of Pregnancy .....	III
Appendix C: Hazardous Materials Incident .....	IV
Appendix D: Radionuclide Use Authorization.....	V
Appendix E: Monthly Radiation Survey .....	VI
Appendix F: Decontamination of Research Equipment.....	VII

## Emergency Contacts and Telephone Numbers

Director of Environmental Health & Safety:	17501
Radiation Safety Officer:	14044
Environmental Health & Safety Fax:	14100
Director of Research Integrity & Education:	16947
Vivarium Director:	14345
Vice Provost of Research & Education:	14843
Dean of Natural Sciences & Mathematics:	12995
Chair of Chemistry & Biochemistry:	12986
Chair of Biological Sciences:	13463
Chair of Physics & Astronomy:	12137
Campus Safety - Emergency:	13000
Campus Safety – Non-Emergency:	12334
Anonymous Compliance/Ethics Reporting Hotline:	(866) 780-0002

## Department of Environmental Health & Safety

The Department of Environmental Health & Safety is located on the Second Floor of the Facilities Service Center. The hours of operation are 8:00 a.m. to 4:30 p.m., Monday through Friday. For after hour emergencies, please call Campus Safety at 1300 or utilize the “DU Safe” phone app.

## Authorized Radioactive Materials

The University of Denver has been authorized to use the following materials based on the Radioactive Materials License, numbered CO 108-05, issued by the State of Colorado via the Colorado Department of Public Health and Environment (CDPHE) Radiation Control Division. The materials and quantities are as follows:

A: 18 millicuries of tritium

B: 2 millicuries of carbon-14

C: 24 millicuries of sulfur-35

D: 25 millicuries of phosphorus-32

E: 23 millicuries of iodine-125

F: 4 nanocuries of plutonium-242

G: 500 microcuries of cisplutonic elements (i.e. atomic numbers 1-94) for the calibration of instruments

H: 100 microcuries of iron-55

Other radioisotopes are not allowed for use by the University of Denver. If so desired, contact the Radiation Safety Officer to request an amendment to the Radiation Materials License. Requests may be denied by the Radiation Safety Officer or by the State of Colorado. Work with radioisotopes outside of the above list is against State law; knowingly violating this list can cause the Principal Investigator in question to be held liable for wrongdoing.



# Requirements of the University

The University is required to follow the following regulations from the CDPHE Radiation Control Division:

## General Provisions (Part 1)

These regulations can be found in 6 CCR 1007-1 Part 01. It is required of the University to maintain all records of receipt, transfer, and disposal of all sources of radiation per 6 CCR 1007-1 Part 1 Section 6 and will be available for inspection at any time from the CDPHE per 6 CCR 1007-1 Part 1 Section 7. The CDPHE may at any time conduct tests of sources of radiation, the facilities in which they are housed, and radiation equipment and instruments per 6 CCR 1007-1 Part 1 Section 8. The CDPHE may enact enforcement action per 6 CCR 1007-1 Part 1 Section 10, may impound radioactive material per 6 CCR 1007-1 Part 1 Section 11, and may prohibit use of radioactive material per 6 CCR 1007-1 Part 1 Section 12. Radioactive materials may only be allowed for use in certain rooms on campus according to the University's Radiation License.

## Licensing of Radioactive Material (Part 3)

These regulations can be found in 6 CCR 1007-1 Part 3. Since the University is a research and development facility, the Radiation Materials License is undefined, however is similar to a "Specific License of Broad Scope" as defined in 6 CCR 1007-1 Part 3 Section 11. The University will follow these requirements (either Type A, Type B, or Type C) based on its current active use. The CDPHE Radiation Control Division may set forth any specific requirements for the University of Denver, as it deems appropriate, as authorized by 6 CCR 1007-1 Part 3 Section 14 to include, but not limited to, minimizing the danger to public health or property; require the use of reports, records and inspections; and prevent the loss or theft of radioactive material. The University is not allowed to transfer radioactive material to

unlicensed individuals according to the University's Radiation License and 6 CCR 1007-1 Part 3 Section 22.

### ***General Requirements of Specific Licenses***

These are general requirements set forth by the CDPHE Radiation Controls Division for issuance of a Specific Use License for radioactive materials use. The University of Denver holds an unspecified research and development license, category 3.M for possession and use of radioactive material for research and development (which does not authorize commercial distribution), numbered CO 108-05; there are no specific requirements for this type of license, however guidelines issued to Type A, B, and C broad scope licenses will be taken into consideration. Several requirements are needed to be met to fulfill the desires of the CDPHE Radiation Controls Division in order for the continued issuance of a specific license:

- I. Qualified applicants, i.e. Principal Investigators and trained laboratory personnel, use radioactive material in order to minimize the danger to public health or property (6 CCR 1007-1 Part 3 Section 9 Paragraph 1).
- II. The University equipment, facilities, and procedures are adequate to minimize the danger to public health or property (6 CCR 1007-1 Part 3 Section 9 Paragraph 2).
- III. The University provides a financial warranty for the establishment and decommissioning of a radiation program (6 CCR 1007-1 Part 3 Section 9 Paragraph 5).

### ***Type A Specific License of Broad Scope***

This is a specific license authorizing the acquisition, possession, use and transfer of radioactive material in any form as specified in the University's license. A Type A license will require the following:

- I: The establishment of a Radiation Safety Committee

- II: The appointment of a Radiation Safety Officer
- III: Control the procurement and use of radioactive materials
- IV: Evaluate the uses of radioactive materials
- V: Require the Radiation Safety Committee to approve all research involving radioactive materials.
- VI: Meet the requirements of a General Requirements of Specific License.

Because a Type A license typically involves radioactive materials in the multicurie range, these procedures do not apply to the University of Denver. Though technically plutonium-242 does not appear in 6 CCR 1007-1 Part 3 Schedule 3D, due to the extremely small amount in possession (limited to four nanocuries) and the limited use, the Type A requirements will not apply to the current specific research.

### ***Type B Specific License of Broad Scope***

This is a specific license authorizing the acquisition, possession, use and transfer of radioactive material as specified in the University's license but is restricted by the CDPHE to certain isotopes as set forth in 6 CCR 1007-1 Part 3 Schedule 3D. For a Type B license, activities are limited to Column I; total activity cannot exceed Unity. A Type B license will require the following:

- I: The appointment of a Radiation Safety Officer
- II: Control the procurement and use of radioactive materials
- III: Evaluate the uses of radioactive materials
- IV: Require the Radiation Safety Officer to approve all research involving radioactive materials.
- V: Meet the requirements of a General Requirements of Specific License.

Because a Type B license typically involves radioactive materials in the curie range, as well as the maximum specified values not exceeding Unity, these procedures do not apply to the University of Denver. During research involving iodine-125, Unity will typically be exceeded based on the low Quantity Limit in Column II, at which point the University will use Type B guidelines; this is due to radioactive iodine presenting a significant health risk to human health via uptake into the thyroid.

### ***Type C Specific License of Broad Scope***

This is a specific license authorizing the acquisition, possession, use and transfer of radioactive material as specified in the University's license but is restricted by the CDPHE to certain isotopes as set forth in 6 CCR 1007-1 Part 3 Schedule 3D. For a Type C license, activities are limited to Column I; total activity cannot exceed Unity. A Type C license will require the following:

- I: The appointment of a Qualified Individual knowledgeable in Radiation Safety
- II: The establishment of administrative controls to assure safe operations.
- III: Meet the requirements of a General Requirements of Specific License.

Based on the current active use and possession, the University will follow Type C guidelines.

### ***Unity***

“Unity” is a term that is used to calculate the limits for an entity that uses more than one type of radioisotope; it appears as the “unity rule” in 6 CCR 1007-1 Part 3 Section 11 Subsection 1 Paragraph 2 Subparagraph 2 and is stated as follows:

“For each radionuclide, determine the ratio of the quantity possessed to the applicable quantity specified in Schedule 3D [...] for that radionuclide.”

Unity is undefined, but likely means 1. In this case, the “applicable value” will be found in 6 CCR 1007-1 Part 3 Schedule 3D. For the University of Denver, the maximum value of Unity is follows as based on our Radioactive Materials License:

<b>Radioisotope</b>	<b>Limits as Specified by the University's License (Ci)</b>	<b>Column I (Ci)</b>	<b>Column II (Ci)</b>	<b>R (Column I)</b>	<b>R (Column II)</b>
Hydrogen-3	0.018	100	1	0.00018	0.018
Carbon-14	0.002	100	1	0.00002	0.002
Sulfur-35	0.024	10	0.1	0.0024	0.24
Phosphorus-32	0.025	1	0.01	0.025	2.5
Iodine-125	0.023	0.1	0.001	0.23	23
Iron-55	0.0001	10	0.1	0.00001	0.001
			<b>Sum of Unity</b>	0.25761	25.761

### ***Timely Decommissioning***

To prevent the occurrence of orphan sources, it is a requirement of State Law for the University to decommission the radiation program in a timely manner. As stated in 6 CCR 1007-1 Part 3 Section 16 Subsection 3 Paragraph 2 Subparagraph 2, if no principal activities have been conducted for a period of 24 months, that the University shall notify the CDPHE to begin the decommissioning process and request license termination.

## **Standards for Protection Against Radiation (Part 4)**

The University of Denver is committed to following *Standards for Protection Against Radiation* located at 6 CCR 1007-1 Part 4 as enforced by the Colorado Department of Public Health and Environment Radioactive Materials Unit.

## **Notices, Instructions and Reports to Workers: Inspections (Part 10)**

The University of Denver is committed to following *Notices, Instructions and Reports to Workers: Inspections* located at 6 CCR 1007-1 Part 10 as enforced by the Colorado Department of Public Health and Environment Radioactive Materials Unit.

## **Transportation of Radioactive Material (Part 17)**

The University of Denver is committed to following *Transportation of Radioactive Material* located at 6 CCR 1007-1 Part 10 as enforced by the Colorado Department of Public Health and Environment Radioactive Materials Unit.

## **Personal Monitoring**

Personal monitoring is required in order to calculate the absorbed dose that personnel will face while working with radioisotopes. Medical records will be maintained in order to calculate lifetime absorbed does.

### **Dosimeters**

Personnel working with detectable radiation shall wear a radiation dosimeter. This device monitors absorbed radiation and should be worn on the lapel of the lab coat. In

addition, all laboratory personnel who handle more than two millicuries of phosphorus-32 are required to wear a finger ring dosimeter. Finger ring dosimeters shall be worn on the hand that is most likely to receive the highest exposure to radiation. Finger ring dosimeters are worn with the name facing towards the palm, inside of any protective gloves.

All dosimeters shall be turned into the Radiation Safety Officer by the tenth of the month. Dosimeters are sent off-site for processing. Medical reports are sent to each laboratory personnel with a copy retained on file by the Radiation Safety Officer.

Prior to the hiring of new laboratory personnel, the Principal Investigator shall contact the Radiation Safety Officer in order to obtain the appropriate dosimeter. Personnel whom have previously worked with radioisotopes will need to complete and submit a **Radiation Exposure History** to the Radiation Safety Officer before performing work. The **Radiation Exposure History** must be completed with a “wet” signature and be either faxed or delivered to the Radiation Safety Officer. Medical privacy regulations require a signed release before exposure records from previous employers can be obtained.

## **Bioassays**

Personnel working in a laboratory that uses iodine-125 must have a baseline bioassay reading prior to start of initial work. If you intend to work with unbound iodine-125, arrange with the Radiation Safety Officer to schedule an initial thyroid scan before starting work. Any laboratory personnel who may be working with greater than ten millicuries of iodine-125 is required by regulation to have a thyroid bioassay. Accidental exposures to iodine-125 of greater than ten millicuries must be evaluated within 72 hours of exposure by a licensed medical professional. Follow up bioassay readings will be taken every two weeks until thyroid measurements have normalized to the initial baseline reading.

## **As Low As Reasonably Achievable (ALARA)**

The potential adverse health effects of low-level radiation exposure include an increased risk of carcinogenesis, mutagenesis, and germline mutagenesis, and are considered to be non-threshold phenomena meaning that even low levels of exposure will increase risk. Threshold Limits have been established regarding occupational radiation exposure and is known as an Occupational Dose Limit. The risk of radiation exposure is less than the Occupational Dose Limit and decreases with magnitude of exposure; the Occupational Dose Limit is set at a low level, however risk of adverse events is still possible. It is the policy of the University of Denver that all exposures must be justified and that they must be 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 CDPHE Radiation Control Division and are based on the NRC Regulations. 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/year

### **University of Denver ALARA Program**

Since radiation exposure levels at the University of Denver are low, the 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 corresponds to 2.5% of the



Occupational Dose Limit and Level II corresponding to 8% of the Occupational Dose Limit. These exposure levels are on a quarterly basis; the appropriate response action is also indicated for each level:

***Total Effective Dose***

Level I: 125 mrem

Level II: 410 mrem

***Eye Dose***

Level I: 375 mrem

Level II: 1.20 rem

***Individual Organ Dose***

Level I: 1.25 rem

Level II: 2.50 rem

***Shallow Dose***

Level I: 1.25 rem

Level II: 2.5 rem

## ***University of Denver Response Actions***

### *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.

### *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.

### *Equal to or greater than Level II:*

There will be an investigation with a report written by the Radiation Safety Officer to document the incident.

## **Declared Pregnant Woman**

In keeping with the recommendations of the National Council for Radiation Protection, it is the policy of the University of Denver to limit the radiation exposure of every Declared Pregnant Employee to 500 mrem for the duration of the pregnancy. Based on the findings of *Chevron U.S.A. Inc. v. Echazabal*, pregnant laboratory personnel will either be assigned to new work duties that do not involve direct radiation exposure or will be placed on administrative leave. These extreme measures are for the protection of the mother and the fetus as radiation has greater negative effects on rapidly dividing cells, such as those found in a developing fetus, in which exposure to radiation could likely to result in birth defects or miscarriage.

## **Definition**

Declared Pregnant Woman means a biological human female who has informed the University, in writing, of their pregnancy including the estimated date of conception.

## **Procedures**

Contact the Radiation Safety Officer at the earliest suspicion of pregnancy; information about the pregnancy will be kept confidential. Complete the **Declaration of Pregnancy** including a “wet” signature and estimated date of conception. The Principal Investigator and the Radiation Safety Officer will review the hazards of radiation with the Declared Pregnant Woman. The employee will be moved to a position involving minimal to no radiation hazard or be put on administrative leave. A pregnancy radiation dosimeter will be assigned and shall be worn at waist level at all times when potential exposure may exist. A memorandum will be issued by the Radiation Safety Officer regarding any additional necessary precautions to assure minimal radiation exposure to the fetus and will be sent to the Principal Investigator, the Declared Pregnant Woman, and kept on file.

## **Accidental Release of Radioactive Materials**

In case of a spill of radioactive materials, address any medical condition first. Injuries take priority over clean-up. 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 visible breaks in the skin surface. Wash heavily with soap and water.

### **Minor Spills (< 100 $\mu$ Ci)**

Immediately notify personnel in the area about the spill. Using disposable gloves, cover

the spill with absorbent mats. Fold the absorbent mats and insert into a plastic bag. Change gloves often to prevent the spread of contamination. Place all possible contaminated material into plastic bag. The area can be cleaned using a radioactive detergent such as Radiac Wash, Lift Away, or Count- Off. Following the cleanup, survey the area and yourself for any potential contamination using an appropriate survey meter. Contact the Radiation Safety Officer to conduct area wipe tests in order to document that area has been decontaminated.

### **Major Spills (> 100 µCi)**

Contact the Radiation Safety Officer immediately. Cover the spill with absorbent paper, but **do not clean up**. Prevent persons from entering the area. Leave the room and lock all doors to prevent entry. 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. Wait for the Radiation Safety Officer to arrive. After-hours, contact Campus Safety at 13000. Fill out **Hazardous Materials Incident Report** and submit to the Radiation Safety Officer and Principal Investigator.

## **Training**

The Principal Investigator of each laboratory that uses radionuclides must become a certified user. No radioactive shipments may be received without the approval/signature of a certified user. Contact the Radiation Safety Officer for information regarding this process. All personnel that work in radioisotope laboratories shall attend initial and refresher radiation safety training. This training will consist of general radiation principles and definitions, radiation protection practices, and CDPHE regulations as well as the University of Denver

radiation safety practices. In addition, researchers will need to pass the Radiation Safety for Occupational Workers examination before starting work.

## **Procuring 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 Radiation License are not violated. The Principal Investigator submits a request for radionuclides procurement to the Radiation Safety Officer.

If a Principal Investigator wishes to order a radionuclide that they have not been previously approved for, they will need to complete the **Application for Radionuclide Use** and submit a copy to the Radiation Safety Officer. If the radionuclide is not specifically listed on the University of Denver Radiation License, an amendment will have to be submitted to CDPHE for the proposed addition. Amending the University of Denver Radiation License could potentially take up to six months for State approval by the CDPHE Radiation Control Division.

## **Tracking Radioactive Material**

All radioactive material will be tracked by the Principal Investigator and the Radiation Safety Officer to adhere to the policies of the NRC, CDPHE, and the University of Denver.

## **Receiving Radioactive Materials**

All orders for radioactive materials must be pre-approved by the Radiation Safety Officer and will monitor all radioactive materials packages received by the University, in accordance with RH 4.32. Packages will be received at the Ritchie School of Engineering and Computer Science - Chemical Receiving, Room 122A, at 2155 E. Wesley Ave, Denver, CO

80208 which will serve as the “storage room” for safe-keeping until delivery. 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. Room 122A will be posted with **Notice to Employees** which will include emergency phone numbers. 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.

The Radiation Safety Officer 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 a University of Denver facility. If a radioactive shipment is received after normal working hours (Monday thru Friday 8am to 4:30pm), the radioactive shipment will be surveyed not later than 3 hours from the beginning of the next working day. Packages needing to be surveyed for exterior surface contamination will be wipe tested. Non-fixed (removable) contamination shall be based upon wiping an area of 100 square centimeters of the surface concerned with an absorbent material, using moderate pressure, and measuring the activity on the wiping material. Wipe samples will be assayed on a liquid scintillation counter, (or LUDLUM Alpha/Beta counter) to determine any potential contamination.

### Non-Fixed External Radioactive Contamination Limits for Packages

Contaminant	Maximum permissible limits		
	Bq/cm <sup>2</sup>	μCi/cm <sup>2</sup>	dpm/cm <sup>2</sup>
Beta and gamma emitters and low toxicity alpha emitters	4	10 <sup>-4</sup>	240
All other alpha emitting radionuclides	0.4	10 <sup>-5</sup>	24

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. Packages deemed to be uncontaminated, per the regulations, will be delivered by the Radiation Safety Officer to the laboratory. The Radiation Safety Officer 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. To open a radioactive material package, the laboratory personnel shall first don appropriate PPE (lab coat, gloves, safety glasses, etc.) and a dosimeter. A ring badge is also required for packages containing more than two millicuries of phosphorus-32. The **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.

While it is the responsibility of the Radiation Safety Officer to maintain records of purchase and disposal, it is the responsibility of the 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 Radiation Safety Officer.

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 Radiation Safety Officer will treat the package as unclaimed. Any type of paperwork discrepancies should be reported to the Radiation Safety Officer as soon as possible. If a package arrives at the laboratory without a **Radioisotope Usage Form**, contact the Radiation Safety Officer so that one may be generated.

Contact the Radiation Safety Officer if a radioactive shipment is expected to be delivered on the weekend.

## Radioactive Material Disposal

All radionuclides will be disposed of via arranged processes with the Radiation Safety Officer. A copy of the **Radioisotope Usage Form**, indicating the total decayed amount of activity being disposed of on the day of the pickup, shall accompany all waste to be collected; a separate copy will be retained for each type of disposal, i.e. solid, liquid, or vial.

### Solid Waste Disposal

Solid waste and vials must be separated and placed in clear, four mil plastic bags. Biohazard bags or waste basket liners will not be accepted. Each bag or container must be segregated by radionuclide and labeled accordingly, including the name of the laboratory generating the waste. For solid ingredients, indicate approximate percent by weight. Solid waste must contain < 0.1% liquid.

### Liquid Waste Disposal

For liquid waste pickups, the concentrations and chemical names of the ingredients must be listed on the **Radioisotope Usage Form**. For example: 10% methanol, 20% chloroform, 70% water, 10  $\mu$ M iodine-125.

### Sink Disposal

Sink disposal of radioactive materials is not allowed at the University of Denver.



## **Defacing Shipping Containers**

All radioactive symbols must be defaced from shipping containers before disposal. 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 Radiation Safety Officer at extension 14044.

## **Laboratory Contamination Surveys**

All restricted areas, during active research, 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 Radiation Safety Officer. 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 during active radiation research. Each area wipe shall be performed on an area of approximately 100 cm<sup>2</sup>. 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 Radiation Safety Officer. 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 Radiation Safety Officer. If survey results are consistently high (over a three-month period), the Radiation Safety Officer will investigate to determine how exposures can be maintained ALARA.

The form titled **Monthly Radiation Survey** is used for area survey reports. This form must be available for review by the Radiation Safety Officer. Failure to comply with this policy will result in the following actions by the Radiation Safety Officer:

1 <sup>st</sup> Violation:	The laboratories radioactive material purchasing privileges will be immediately suspended until the required documentation is received.
2 <sup>nd</sup> Violation:	Within one year of the 1 <sup>st</sup> 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 Radiation Safety Officer as soon as possible by the Principal Investigator. Planned delays, such as vacations, will require prior notification in order to make sure that dosimeters are able to be collected by the 10<sup>th</sup> of the month.

## **Moving or Decommissioning Radioactive Instruments**

Large laboratory equipment used in isotope work that is either scheduled to be moved to a new location on campus, decommissioned for disposal, or serviced by an outside contractor (via transportation off-site), shall be properly decontaminated prior to such action. The **Decontamination of Research Equipment** 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 Radiation Safety Officer will then verify that the equipment has been properly decontaminated and will inform the appropriate parties.

## **Radiation Survey Meters**

For Principal Investigators that possess radioactive materials that are capable of being detected by handheld survey meters, notify the Radiation Safety Officer to ensure that all survey meters are calibrated annually. All survey meters in active use shall be placed into a regular calibration cycle to be conducted annually.

## **Security of Radioactive Materials**

Security of all licensed or registered sources of radiation is required to prevent unauthorized removal and shall be in accordance with RH 4.25 and RH 4.26. All stock vials will be secured when not in use and laboratory doors shall be locked when the lab is unoccupied. All radionuclide research laboratories shall be prevented from 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 Radiation Safety Officer shall be notified before any shipment of radioactive material occurs in order for the University and the Principal Investigator to be in compliance with appropriate State and Federal regulations.

## **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 is not permitted in radiation laboratories. Consumption/storage of food or beverages is not permitted in radiation laboratory areas or in refrigerators or freezers containing radioactive and/or other hazardous material.

## References

*Chevron U.S.A. Inc. v. Echazabal*, 536 U.S. 73 (2002)

Colorado Department of Public Health & Environment, Hazardous Materials and Waste Management Division. 2007. "Radiation Control - General Provisions". *Code of Colorado Regulations*, title 6, chapter 1007, subchapter 1, part 1 (Nov. 14, 2017).

Colorado Department of Public Health & Environment, Hazardous Materials and Waste Management Division. 2007. "Radiation Control - Standards for Protection Against Radiation". *Code of Colorado Regulations*, title 6, chapter 1007, subchapter 1, part 4 (Dec. 15, 2023).

Colorado Department of Public Health & Environment, Hazardous Materials and Waste Management Division. 2014. "Radiation Control - Notices, Instructions, and Reports to Workers: Inspections". *Code of Colorado Regulations*, title 6, chapter 1007, subchapter 1, part 10 (Oct. 1, 2014).

Colorado Department of Public Health & Environment, Hazardous Materials and Waste Management Division. 2014. "Radiation Control - Transportation of Radioactive Materials". *Code of Colorado Regulations*, title 6, chapter 1007, subchapter 1, part 17 (Dec. 15, 2022).

# Appendix A: Radiation Exposure History

The Department of Environmental Health & Safety maintains the previous exposure histories of current employees as required by the CDPHE RH 4.10 and 4.44. This form shall be printed out and signed and dated with blue or black ink.

Participant #:		Spare Dosimeter #:	
Index #:		Spare Ring Dosimeter #:	

Name: \_\_\_\_\_ Birthdate (MM/DD/YYYY): \_\_\_\_\_

Department: \_\_\_\_\_ Principal Investigator: \_\_\_\_\_

I authorize the release of my radiation exposure records to the University of Denver Department of Environmental Health & Safety:

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

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

Previous Institution: \_\_\_\_\_

Address: \_\_\_\_\_

City: \_\_\_\_\_ State (Country): \_\_\_\_\_ Zip Code: \_\_\_\_\_

Contact Person: \_\_\_\_\_

Dates Worked: From \_\_\_\_ / \_\_\_\_ / \_\_\_\_ To \_\_\_\_ / \_\_\_\_ / \_\_\_\_

Previous Institution: \_\_\_\_\_

Address: \_\_\_\_\_

City: \_\_\_\_\_ State (Country): \_\_\_\_\_ Zip Code: \_\_\_\_\_

Contact Person: \_\_\_\_\_

Dates Worked: From \_\_\_\_ / \_\_\_\_ / \_\_\_\_ To \_\_\_\_ / \_\_\_\_ / \_\_\_\_

## Appendix B: Declaration of Pregnancy

Name of Individual: \_\_\_\_\_

Principal Investigator: \_\_\_\_\_

Approximate Conception Date: \_\_\_\_\_

Estimated Due Date: \_\_\_\_\_

### Declared Pregnant Woman

By providing this information, I am declaring myself to be pregnant as of the date shown above. I understand that preventative measures of ALARA mean that my work duties will be reassigned to an area that will not expose myself, or the developing fetus, to radioactive exposure based on the Supreme Court case of *Chevron U.S.A. Inc. v. Echazabal* relating to occupational health exposure. I understand that not voluntarily reassigning my work duties means that I will be placed on a temporary leave of absence for the duration of the pregnancy.

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

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

### Principal Investigator

I have received notification from the above-named individual that they are pregnant. I have evaluated their prior occupational exposure and have established appropriate measures to control the dose to embryo/fetus in accordance with ALARA which includes a reassignment of duties that does not expose them to radiation. I have explained to them that failure to reassign duties will result in a temporary leave of absence for the duration of the pregnancy.

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

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

# Appendix C: Hazardous Materials Incident

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

Describe Incident:

---

---

---

---

Chemicals/Radionuclides Involved: \_\_\_\_\_

Persons Contaminated/Injured: \_\_\_\_\_

Injuries: \_\_\_\_\_

Medical Actions Taken: \_\_\_\_\_

Wipe Test Results:

Vial #1 \_\_\_\_\_ beta/gamma dpm

Vial #2 \_\_\_\_\_ beta/gamma dpm

Vial #3 \_\_\_\_\_ beta/gamma dpm

Actions Taken to Prevent Recurrence:

---

---

---

Comments:

---



# Appendix D: Radionuclide Use Authorization

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

Email: \_\_\_\_\_

Phone: \_\_\_\_\_

Laboratory Locations: \_\_\_\_\_

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

Only radionuclides that are on the University's Radiation Materials License may be ordered.

Radionuclide	Physical form	Activity (mCi) of each order	Frequency of Purchase

## Principal Investigator

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

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

## Radiation Safety Officer

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

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



## Appendix F: Decontamination of Research Equipment

Please complete and return to the Radiation Safety Officer. Please allow sufficient time before work starts; moving large pieces of equipment may require an outside contractor. All equipment must be decontaminated and checked by the Radiation Safety Officer prior to being serviced (via transportation off campus) or moved.

Principal Investigator: \_\_\_\_\_

Equipment: \_\_\_\_\_

Building and Room Location: \_\_\_\_\_

Person Conducting Decontamination: \_\_\_\_\_

Have the applicable utilities been disconnected? (Y/N): \_\_\_\_\_

Explain the Functions of the Equipment: \_\_\_\_\_

Remove all chemicals from equipment to prevent accidental spills. Wipe the piece of equipment with an appropriate cleaning agent. If used with potential biohazards, use an appropriate disinfectant. Wipe down the piece of equipment with an appropriate radioactive material decontaminate solution. Let the equipment air out overnight. 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.

### Principal Investigator

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

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

### Radiation Safety Officer

This piece of equipment has passed inspection.

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