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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.

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Emergency Contacts and Telephone Numbers

Director of Environmental Health & Safety:	7501
Radiation Safety Officer:	4044
Environmental Health & Safety Fax:	14100
Director of Research Integrity & Education:	16947
Vivarium Director:	14345
Vice Provost of Research & Education:	4843
Dean of Natural Sciences & Mathematics:	12995
Chair of Chemistry & Biochemistry:	12986
Chair of Biological Sciences:	13463
Chair of Physics & Astronomy:	12137
Campus Safety- Emergency	3000
Campus Safety –Non-Emergency	12334
Anonymous Compliance/Ethics Reporting Hotline	(866) 7800002

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 1005, 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 take 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 unduly restrictive, 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-

unlicensed individuals according to the University's Radiation License and 6 CCR 1007.1 Part 3 Section 22.

General Requirements of Specific Licenses

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, the procedures do not apply to the University of Denver. Though technically plutonium

Because a Type B license typically involves radioactive materials in the curie ranges 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 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

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:

Radioisotope	Limits as Specified by the University's License (Ci)	Column I (Ci)	Column II (Ci)	R (Column I)	R (Column II)
Hydrogen-3	0.018				

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

addition, all laboratory personnel who handle more than two millicuries of phosphorus-32 are required to wear a fingerring dosimeter. Finger ring dosimeters shall be worn on the hand that is most likely to receive the highest exposure to radiation. Fingerring 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 whom 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

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

80208 which will serve as the “storage room” for safe-keeping until delivery. ECS122A 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 ²	μCi/cm ²	dpm/cm ²

Beta and gamma emitters and low

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 1

The form titled Monthly Radiation Survey

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 ,

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. Echazaba 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. 15, 2017).

ent of Public Health & Environment, Hazardous Materials and Waste
t Division. 2014. "Radiation Control - Transportation of Radioactive
ode of Colorado Regulations title 6, chapter 1007, subchapter , part 17
22).

Appendix A: Radiation Exposure History

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

Participant #:		Spare Dosimeter #:	
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Index#:

Spare Ring Dosimeter #:

Appendix C: Hazardous Materials Incident

Date: _____ Location: _____

Describe Incident:

Chemicals/Radionuclides Involved: _____

Persons Contaminated/Injured: _____

Injuries: _____

Medical Actions Taken: _____

Wipe Test M_____cab_____ 1 Tc (de 0 Tc/____)g-4 (0 Tcm (dem (de 0-9Tc _)10 p(1l)-1ic

Appendix E: Monthly Radiation Survey

Month/Year: _____

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



Appendix F: Decontamination of Research