



RADIATION SAFETY MANUAL

*University of Nevada, Las Vegas
Risk Management and Safety*

Responsible Office: Radiation Safety Office
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REVISION HISTORY

<u>Rev. No.</u>	<u>Effective Date</u>	<u>Description of Revision</u>
2	12/29/17	Revised to incorporate corrective actions required in response to the State of Nevada, Radiation Control Program violations issued on November 30, 2017.
 Chair of the Radiation Safety Committee: Signature: _____ Date: _____		
1	03/28/14	Revised to incorporate items required by the State of Nevada, Radiation Control Program, Control Number R9423 . Also included are revisions meant to satisfy the requirements for application for a Type A License of Broad Scope (e-mail from the State of Nevada, Radiation Control Program dated January 9, 2014).
0	10/31/12	Revised to incorporate items required in a letter from the State of Nevada, Radiation Control Program – Control Number: AA9106 ; to add a “Revision History” page; to add an “Acronyms and Abbreviations” page; and to insert Form 23 and 23A.

PREFACE

This Radiation Safety Manual contains the policy, regulations, and procedures for the safe use of radiation sources and radiation producing devices at the University of Nevada, Las Vegas. Although overall responsibility for radiation safety rests with the University, basic responsibility for the protection of life and property must remain with the individual user of the radiation source or radiation-producing device. Thus, this individual must possess certain acceptable qualifications and follow designated policies and required procedures as outlined in this Manual.

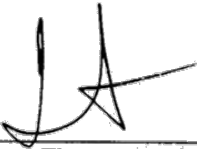

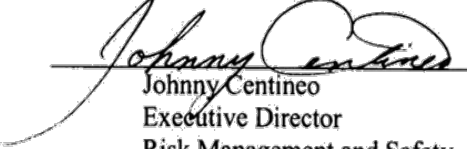
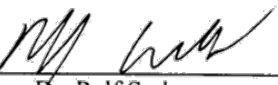
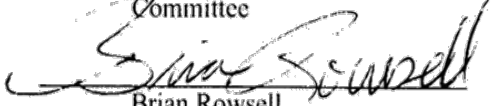
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SECTION 1: POLICY

I: INTRODUCTION

Radionuclides used in research, industry, education and medicine are valuable assets which can benefit society if properly used. They can, however, present hazards because of their ability to irradiate and contaminate humans and our environment. As a consequence, persons who use radiation sources must understand the various types of radiation hazards and adhere to regulations and standard practices designed to ensure their safe use.

The University of Nevada, Las Vegas (UNLV) is licensed by the State of Nevada Radiation Control Program. Radiation sources at UNLV are regulated in accordance with the provisions of Nevada Administrative Code (NAC) 459.

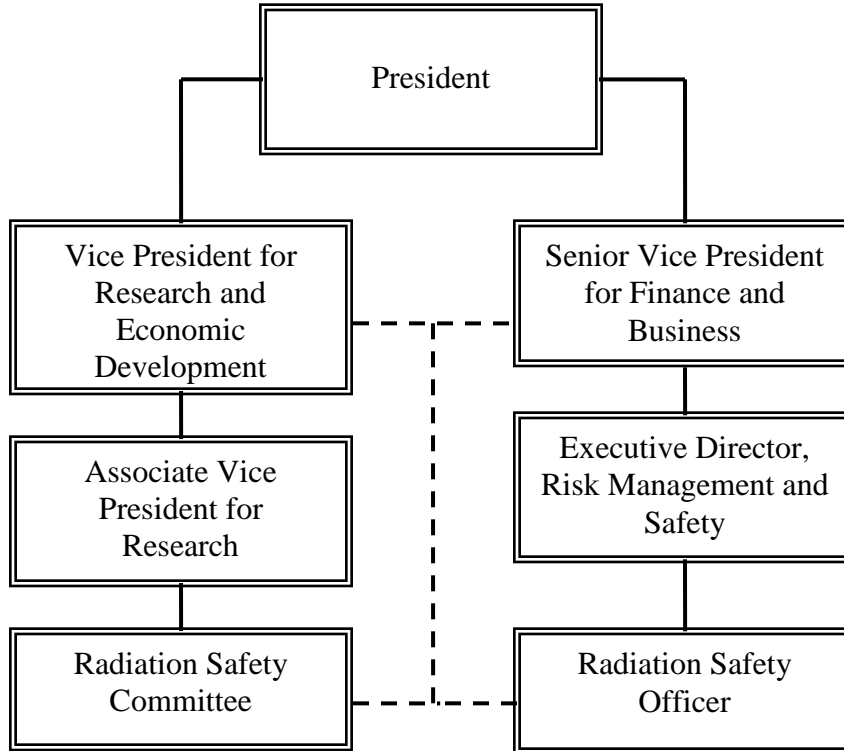
This Radiation Safety Manual describes the applicable regulations, policies, and procedures on which the UNLV Radiation Safety Program is based. Legally binding Federal and State regulations require the maintenance of certain records and the fulfillment of certain obligations by all Authorized Users.

This Manual describes the organization and responsibilities outlined in UNLV's comprehensive radiation safety program, including the radiation related services available to each user of a radiation source. The Manual was prepared to be consistent with all applicable Federal and State regulations.

Compliance with License requirements does not in itself ensure a safe program; additional policies and procedures have been specified in this Manual to enhance the Radiation Safety Program. [NOTE: Any additions or modifications of Policies or Procedures remain the responsibility of the Radiation Safety Committee (RSC). Such changes will occur as revisions or additions to this Manual become necessary for purposes of clarification, changes in title or positions, and other reasons. These changes shall in no way result in a decrease in effectiveness of the Radiation Safety Program or a change in existing license conditions.]

II: AUTHORITY, ORGANIZATION AND RESPONSIBILITY

A. CHAIN OF AUTHORITY



The University of Nevada, Las Vegas Radiation Safety Program operates under the leadership of the Vice President for Research & Economic Development and the Senior Vice President for Finance and Business. The Program consists of a Radiation Safety Committee, the Radiation Safety Office within the Department of Risk Management and Safety; the Radiation Safety Officer, Authorized Users and Radiation Workers.

B. RADIATION SAFETY COMMITTEE: POLICY AND RULES

I. BACKGROUND

The University of Nevada, Las Vegas (UNLV) procures and uses radionuclides under a Broad Scope Type A Radioactive Materials License No. 03-13-0305-01 and a Service License No. 03-13-0305-02, granted by the State of Nevada, Radiation Control Program. The Type A Broad Scope license requires the establishment of a Radiation Safety Committee (RSC) to develop, direct, and oversee the operation of the University's Radiation Safety Program (RSP). The RSC receives its authority from the UNLV President through the Vice President for Research and Economic Development (VPRED) and functions under the direction of the Associate Vice President for Research.

The RSC works with executive management and the Radiation Safety Officer (RSO) in implementing the Radiation Safety Program. The RSC and RSO are committed to the philosophy of maintaining all radiation doses to workers and members of the public As Low As Reasonably Achievable (ALARA).

In accomplishing its responsibilities, the RSC will make every effort to:

- Implement the ALARA concept;
- Control and ensure the safe use of radioactive materials and radiation producing equipment (devices);
- Ensure compliance with applicable federal and state regulations; and
- Ensure compliance with UNLV procedures and policies as described in the Radiation Safety Manual.

II. RESPONSIBILITIES

The RSP at UNLV is governed by the members of the RSC. This committee is a group of faculty and professional staff, appointed by the VPRED, who have the necessary experience, expertise, and knowledge to establish policy for the use of radioactive material, and to oversee all aspects of radiation safety at UNLV. The RSC includes the RSO, who is a permanent committee member. The duties of the Radiation Safety Committee are to:

1. Review quarterly, with the assistance of the RSO, a summary of the dosimetry data of all personnel working with Radioactive Material (RAM), Radiation Producing Equipment and/or Devices (RPE, RPDs) at UNLV and who are participants in the dosimetry program, and ensure that any corrective action for exposures which exceed permissible levels is implemented.
2. Review, with the assistance of the RSO, radiation survey data and provide recommendations on ways to maintain individual and collective doses at or below

ALARA and oversee implementation of approved program changes intended to achieve this goal.

3. Review at least quarterly, with the assistance of the RSO, any significant incidents involving RAM, RPE, or RPD with respect to the cause and subsequent actions taken, and provide recommendation to prevent such events in the future.
4. Review, with the assistance of the RSO, requests for permission to use RAM, RPE, or RPD at UNLV, and approve or disapprove on the basis of safety, user training and experience and procedure safety.
5. Review, with the assistance of the RSO, overall compliance status for authorized users of RAM, RPE, or RPD at UNLV.
6. Review, with the advice of the RSO, and approve or disapprove on the basis of safety, the use of any research laboratory located at UNLV for use of RAM, RPE, or RPD. Laboratories no longer using RAM, RPE, or RPD may be released for general use after a final status survey has been performed on the laboratory by the RSO and the results have met appropriate regulatory release criteria.
7. Review, with the advice of the RSO, any program or procedure involving the use of RAM, RPE, or RPD which has been suspended by the RSO and provide recommendations for further corrective, safety or efficiency improving actions or disposition.
8. Review, with the assistance of the RSO, results of an annual audit of the RSP at UNLV and ensure the implementation of any recommended improvements.
9. Review, with the advice of the RSO, and approve or disapprove on the basis of safety, any request for amendment or renewal of UNLV's Type A Broad Scope License.
10. Review, with the advice of the RSO, and approve or disapprove on the basis of safety, changes in procedures and policies in the RSP at UNLV.

III. QUALIFICATIONS AND APPOINTMENT

A. MEMBERSHIP

The RSC is appointed by the VPRED. The RSO is a permanent voting member of the committee and all of its subcommittees. The Chair shall be designated by the VPRED and shall be a tenured faculty member. A Vice Chair, who will conduct meetings should the Chair be unable to attend, shall also be appointed and must also be a tenured faculty member. In addition, both Chair and Vice Chair shall have been active Authorized Users for the year preceding their appointment.

B. REPRESENTATION

At a minimum the membership of the RSC shall include:

- The VPRED or his/her designee;
- The Senior Vice President for Finance & Business or his/her designee;
- The Radiation Safety Officer (RSO);
- Faculty knowledgeable in the use of ionizing radiation, including representatives of the Schools and Colleges whose members use ionizing radiation.

Serving as an RSC member is an important role of faculty. It is recognized and appreciated that members serve in addition to their regular teaching, research and other service. Therefore, it is understood that on occasion a member may need to miss a scheduled RSC meeting. If a member cannot attend a meeting, he/she should notify the RSC Chair in advance (as soon as practicable) so that an alternate can be secured. Because members serve at the pleasure of UNLV, failing to regularly attend meetings or the lack of diligence in performing duties may result in removal of a member from the RSC by the VPRED.

C. QUALIFICATIONS

All members of the RSC shall have documented experience and training in regards to his or her areas of expertise and/or documented experience and training in regards to the use and control of RAM, RPE, and/or RPD.

D. TERMS OF APPOINTMENT

With the exception of the RSO, who is a permanent member, all RSC members will be appointed for terms of three years. Reappointment to consecutive terms is permissible.

IV. CONDUCT OF BUSINESS

A. MEETINGS

1. The RSC will meet on a regular basis but at least quarterly.
2. Ad hoc meetings may be called by the Chair as needs arise, in which case members will be given as much notice as possible, normally at least 5 working days. Meetings called to address issues involved in an abnormal event may be held as soon as a quorum of members can be assembled.
3. Should the Chair be unable to attend a meeting, the Vice Chair will conduct meetings of the committee.
4. A quorum must be declared in order to conduct business. Among those present **MUST BE** the Chair or Vice Chair, the RSO, the executive management

representatives (or alternates), as well as any other member with specific expertise required to address any agenda item upon which a vote is required. A numerical majority is desirable; however the Chair shall determine whether or not a quorum exists in regards to the above requirements.

5. Votes on routine matters, e.g., new applications for use of RAM or RPE, may be expedited using mail, facsimile transmission, e-mail, or telephone voting, provided every member of the Committee has received the material to be voted on and the requirements for a quorum, as specified in the previous paragraph, have been met.
6. In questions of procedure, membership, or voting, the final authority shall be Robert's Rules of Order Newly Revised, 11th Ed (RONR).

B. REVIEW AND CONSIDERATION OF APPLICATIONS FOR USE OF RADIOACTIVE MATERIALS OR RADIATION PRODUCING EQUIPMENT

1. Persons wishing to obtain authorization for use of RAM, RPE, or RPD's shall first submit a completed RSO Form 18 to the RSO.
2. The RSO will then review the application and note his/her recommendation regarding approval, disapproval, or approval with modifications and convey those recommendations to the RSC Chair.
3. The application, along with the RSO's comments and recommendations, will be forwarded to all RSC members by the RSC Chair, either for expedited review or consideration at the next quarterly or Ad Hoc meeting.
4. The RSC Chair shall convey to the applicant any questions, comments, or suggestions for modifications raised by Committee members and, in turn, convey the applicant's responses to the Committee members and RSO.
5. Upon satisfactory resolution of any questions, comments, or suggestions for modifications raised by RSC members, the RSC shall vote on the application. The possible outcomes of the vote are "Approval" (either "as submitted" or "in accordance with agreed-upon changes"), "Disapproval" (resubmission is permitted), or "Approval with Mandatory Modifications." The RSC Chair shall notify the applicant of the results of the RSC's deliberations, with copies of all correspondence to the RSO.
6. An approved Radiation Use Authorization (RUA) shall remain in effect for two years at which time it will be reviewed by the RSO. The RSO will then provide a recommendation to the RSC regarding approval, disapproval, or approval with modifications.
7. RUA's may be suspended or canceled by the RSC "for cause," e.g., repeated failure to adhere to the provisions of the University's Radiation Safety Manual, repeated failure to submit required documentation in a timely and accurate manner, repeated

failure to obtain or use RAM or RPE in accordance with established procedures, or blatant disregard for established safety procedures and policies.

C. REVIEW AND CONSIDERATION OF REQUESTS TO MODIFY APPROVED RADIATION USE AUTHORIZATIONS

1. Requests to modify approved RUA's will be submitted to the RSO in writing.
2. The RSO will then review the request and take one of the following actions:
 - a. If the requested change is considered by the RSO to be a "minor" one, he/she may approve it without consultation with the RSC; however, the RSC shall be informed of all RSO approved authorization changes at the next RSC meeting;
 - b. If the requested change is considered by the RSO to be a "significant" one, he/she may approve it after consultation with the RSC Chair; however, the RSC shall be informed of all RSO/Chair approved authorization changes at the next RSC meeting; or
 - c. If the requested change is considered by the RSO to be a "major" one, he/she shall refer it to the RSC for review, consideration, and action as required for new authorizations.
3. Upon completion of the change of the RUA, either the RSO or Chair of the RSC, as appropriate, shall notify the applicant of the final determination in regards to his/her request.

D. REVIEW AND DISPOSITION OF ABNORMAL EVENTS

1. The RSO shall initiate and document appropriate responses to, and investigations of, any abnormal events regarding RAM or RPE (e.g., isotope spills, accidental human exposure to radiation, and so forth). Copies of all such documentation shall be provided to all members of the RSC (such copies may be redacted in accordance with laws applicable to excluded legally privileged or protected information).
2. The RSO shall inform the RSC Chair whenever an abnormal event has occurred. The Chair and RSO shall determine whether, and to what degree, the RSC and senior management need to be involved in the immediate response to the event.
3. Following completion of the response(s) to, investigation of, and documentation of the event, the RSC shall review all aspects and either concur with the RSO's actions and documentation or recommend additional action.
4. The RSC shall ensure that any corrective or preventive procedures or policies, or user penalties, identified by the RSO and/or the RSC, are implemented in an expeditious manner.

E. REVIEW AND ACTION REGARDING EXPOSURE DOCUMENTATION

1. On a quarterly basis, the RSO shall provide the RSC with a summary of the radiation exposure experienced by those persons enrolled in the monitoring program.
2. Should an exposure above administrative levels of 125 mRem in a three month period be discovered through the dosimetry monitoring program, the RSO shall notify the AU responsible for the affected person(s) and initiate an investigation to determine what caused the exposure.
3. The RSO shall document the results of any investigation of exposure above the administrative limit, as well as any recommended corrective action to prevent recurrences of the exposure.
4. The RSO shall ensure that recommended corrective action(s) are implemented in an expeditious manner.
5. Copies of the documentation referred to in the previous paragraph shall be provided to all members of the RSC.
6. If the RSC concurs with the RSO's recommendation(s) regarding corrective action(s), the RSC shall ensure that the recommendation(s) have been implemented in accordance with the RSO's instructions.

F. REVIEW OF USER COMPLAINTS

1. RAM and RPE users who have concerns or complaints regarding the University's Radiation Safety Program and are unable to resolve these with the RSO, should submit them to the department representative who will forward them to the RSC Chair.
2. The RSC Chair shall initiate a review of the expressed concerns or complaints using procedures of his/her choosing, issue a report identifying problems and proposing corrective actions. Copies of the report shall be distributed to all RSC members.
3. The RSC shall review the report and decide on a final response regarding the problem. If the response includes action on the part of RSC and/or the RSO, the RSC and RSO will ensure that corrective actions are implemented in an expeditious manner.

G. ANNUAL AUDITS

1. The RSC shall conduct an Annual Audit of the RSP which shall consist of, but not be necessarily limited to, the following components:
 - a. A thorough review of the RSO's Annual Report, paying particular attention

to any indications of program non-compliance;

- b. A "cradle to grave" audit of 1% to 2% of the orders for RAM, randomly selected, to include review of the User's request for purchase, the RSO's approval of the request, the receipt and distribution of the RAM, and documentation regarding the use and disposal of the RAM in the User's laboratory;
 - c. A thorough review of the documentation regarding inventories, area surveys, RAM security provisions, waste logs and storage, and annual re-training participation by staff in 5% to 10% of the User laboratories; and
 - d. A complete re-review of all abnormal events and the outcomes thereof, including the status of any corrective actions implemented.
2. The RSC shall prepare a Report of Findings and Recommendations in regards to the Annual Audit and ensure that recommended changes to the RSP are implemented in an expeditious manner.

C. DEPARTMENT OF RISK MANAGEMENT AND SAFETY (RMS)

The Radiation Safety Office receives its authority from the UNLV President through the Senior Vice President of Finance and Business and the Risk Management and Safety Department.

The day-to-day operation of the Radiation Safety Program is managed within the RMS by the Radiation Safety Office, which includes the RSO.

Services provided by the Radiation Safety Office include:

- Approval of radioactive material orders and receipt of radioactive materials
- Personnel monitoring and dosimetry services
- Laboratory radiation contamination surveys
- Training
- Bioassay
- Radiation instrument calibration
- Radioactive waste management
- Transportation and shipping assistance
- Emergency assistance
- Consultation on laboratory design, shielding, and matters related to radiation safety, science or control.

D. RADIATION SAFETY OFFICER (RSO)

The RSO is responsible for managing the radiation safety program; identifying radiation safety problems; initiating, recommending, or providing corrective actions; verifying implementation of corrective actions; and ensuring compliance with regulations for the use of radioactive material. In the absence of the RSO, the Alternate Radiation Safety Officer (ARSO) assumes duties and responsibilities of the RSO.

The RSO has the authority to immediately stop any operations involving the use of radioactive material in which health and safety may be compromised or may result in non-compliance with requirements of NAC 459.010-794, inclusive, or with the UNLV's radioactive material license requirements.

The RSO is responsible for day-to-day management of the Radiation Safety Program.

The RSO, in addition to administering and directing the operations of the Radiation Safety Office, reviews all applications for use of radiation sources.

The RSO is a member of the RSC and all ad hoc committees and sub-committees that are under the RSC's purview.

The RSO investigates incidents and recommends corrective actions. Reports are provided to the parties involved, to the RSC, to executive management, and when appropriate, to regulatory authorities.

E. ALTERNATE RADIATION SAFETY OFFICER (ARSO)

The Alternate Radiation Safety Officer shall assume duties:

- A. When the RSO is unable to fulfill the duties of the Radiation Safety Office;
- B. As delegated by the RSO.

F. AUTHORIZED USER (AU)

Authorized Users are faculty or staff members who have been approved to use radioactive materials or radiation producing devices by the RSC. In addition to other responsibilities, the AU must comply with all requirements for the Radiation Worker. The AU's radiation use must follow the approved procedures and conditions stated in his/her RUA.

The AU has the primary responsibility for ensuring the health and safety of anyone using or affected by the use of the radiation sources under the AU's direction or supervision.

The AU ensures that any person acting under his/her supervision is trained in accordance with UNLV Policy and is aware of the radiation hazards associated with the activity of the materials in use, as well as procedures specified in all related protocols.

The AU ensures that supervised employees and visitors comply with relevant regulations, policies, and procedures.

G. RADIATION WORKER

A radiation worker is anyone who uses radioactive materials (RAM) or radiation producing devices and has received approved radiation safety training and specific radiation use procedures from the AU.

Radiation workers must:

- Complete Radiation Safety Training according to the requirements of this manual, and complete annual radiation safety refresher courses;
- Comply with all applicable regulations, the UNLV Radiation Safety Manual, policies and procedures, and conditions in the RUA;
- Be familiar with the radiological properties and safety precautions for the RAM used in their laboratory;
- Handle RAM and all radiation sources in a responsible manner so as to maintain occupational radiation exposure As Low As Reasonably Achievable (ALARA);
- Secure RAM to prevent unauthorized access. RAM must be under the immediate supervision of a radiation worker within the laboratory or stored in a secure manner when not in use;
- Notify the RSO of any emergency involving RAM.

NOTE: The above descriptions of responsibilities are not exhaustive. Further details of duties and responsibilities of the Authorized User and Radiation Worker are delineated in the body of this document.

Persons working under an Authorized User must follow the policies and procedures as outlined in this Manual. They must use radiation sources only in the manner specified in the application for authorization to use such source(s), or in updated protocols.

- a. The RSO is responsible for carrying out the University policies on radiation safety and for assuring compliance with all Federal and State regulations.
- b. On matters of radiation safety, the RSO is authorized to intervene directly to prevent hazardous conditions from developing and to eliminate existing unsafe conditions.

III: DOSE AND CONTAMINATION CONTROL LIMITS

A. OCCUPATIONAL AND NON-OCCUPATIONAL DOSE CONTROL LIMITS

It is UNLV's policy to maintain human radiation exposure levels "As Low As Reasonably Achievable". Annual limits for occupational radiation exposure are listed in the table below and in NAC 459.325. The dose in any area accessible to the general public shall not exceed 0.002 rem (0.02 mSv) in any 1 hour or 0.1 rem (1.0 mSv) per year in accordance with NAC 459.335.

Annual Limits for Occupational Radiation Exposure	
Total Effective Dose Equivalent	5000 mrem (0.05 Sv)
Any Organ Except Lens of Eye	50000 mrem (0.5 Sv)
Skin and Extremities (Shallow Dose Equivalent)	50000 mrem (0.50 Sv)
Lens of Eye (Lens Dose Equivalent)	15000 mrem (0.15 Sv)
Declared Pregnant Worker	500 mrem (0.005 Sv) duration of pregnancy
Annual Limits for Non-Occupational Radiation Exposure	
General Public	100 mrem (0.001 Sv)

UNLV administrative control limits are 10% of the annual limits excluding the general public and declared pregnant worker limits. The administrative limits for the general public and declared pregnant worker are the same as the annual limits.

B. CONTAMINATION CONTROL LIMITS

The administrative permissible levels of contamination are listed below. It is UNLV's policy however, to maintain contamination levels As Low As Reasonably Achievable. These values reflect the net activity determined by wipe tests. Contamination above background level will normally be required to be decontaminated according to ALARA principles.

Area	Alpha emitter/100cm²	Beta and Gamma/100cm²
Uncontrolled	11 DPM	110 DPM
Controlled	22 DPM	550 DPM
Restricted	110 DPM	1100 DPM

If a Radiation Safety Office survey indicates contamination in excess of the limits shown above, the RSO will be immediately informed and written notification will be sent to the Authorized User. The AU will then provide documentation of radiation safety discussions with the lab workers and provide their names to the RSO. This documentation will include any causes determined and corrective actions taken or planned. This is in addition to the requirement that such contamination must be decontaminated to ALARA levels and a confirmation survey submitted to the RSO.

Routine surveys conducted by AU's that indicate contamination in excess of the administrative limits will require the AU to notify the RSO. Again, this is in addition to the requirement that such contamination must be decontaminated to ALARA levels, and a confirmation survey submitted to the RSO.

IV: HANDLING POLICIES

A. SAFE WORK PRACTICES

Good housekeeping is required wherever radionuclides are used. Work areas must be clearly defined and remain uncluttered.

Work surfaces should be covered to facilitate easy decontamination. Absorbent bench coverings should be changed frequently, i.e., weekly, or whenever the covering is noticeably soiled, torn, or contaminated.

Work areas should be located away from heavy traffic or doorways.

When a radioactive solution is moved between approved locations, the material should be placed in a secondary container, and should be covered to aid in preventing spills

B. RADIATION SAFETY TRAINING

1. Persons planning to work with RAM must be familiar with the properties of radioisotopes used. To ensure such knowledge, all radiation workers must receive radiation safety training by the Radiation Safety Office **PRIOR TO THE COMMENCEMENT OF SUCH WORK:**

- a. Radiation safety training is provided. After receiving initial training, course attendees are given an “Acknowledgement of Training” form and an acknowledgement of reading and understanding the UNLV Radiation Safety Manual form to complete. These forms are kept on file by the Radiation Safety Office as proof of training. The AU also provides training in laboratory specific policies and procedures for associated radiation workers. Annual refresher training is required.
 - b. Requirements for ionizing radiation training can be fulfilled with training provided by the RSO, a member of the Radiation Safety Staff, or another approved instructor. Radiation safety guidelines will be presented before laboratory work begins.
2. Temporary radiation workers can be approved by the RSO.
 - a. Temporary radiation workers (radiation work period less than or equal to two weeks) may use RAM under the direct supervision of the AU or the radiation worker who is familiar with the RAM use in the laboratory. Appropriate radiation safety training is mandatory.

C. RADIATION USE BY PREGNANT WOMEN

It is the policy of UNLV to assure that the unborn children of UNLV’s employees and students shall be protected to the greatest extent possible. The dose limit for the embryo/fetus of a declared pregnant woman is 500 mrem; this limit is for the entire gestation period.

This policy applies to all declared pregnant women. The State of Nevada defines a declared pregnant woman as a woman who has voluntarily informed her employer, in writing, of her pregnancy and the estimated date of conception.

It is the fundamental responsibility of the pregnant worker to decide when and if she will formally declare her condition to her employer. Any person who has questions or concerns about declaring pregnancy is strongly encouraged to contact the RSO.

D. STORAGE OF RADIOACTIVE MATERIALS

When not in active use, radioactive materials shall be secured in a manner that will prevent unauthorized access or removal. Storage sites shall not create Radiation Areas, and radiation must be shielded or sealed to keep exposures ALARA. **Radioisotopes must never be left unsecured in unoccupied laboratories.**

E. LABELING OF CONTAINERS

Containers of radioactive material for storage, processing, or use shall be individually and conspicuously labeled "Caution-Radioactive Material." Containers exempt from labeling must meet the conditions specified in NAC 459.3575. In addition, the label must specify the identity of the radioisotope, the estimated activity (amount), and the date. Containers with less than exempt quantity or concentrations of radioactive material may be placed in properly labeled secondary containers for storage. Containers of radioactive materials not labeled as such are subject to impoundment. Empty and clean containers must have labels removed or defaced.

F. POSTING OF AREAS FOR USE OF RADIOACTIVE MATERIALS

1. ROOMS AND WORK AREAS

All rooms in which more than exempt quantities or concentrations of radioactive materials are used or stored shall be so designated in writing by the Radiation Safety Officer and shall be posted appropriately "**CAUTION - RADIOACTIVE MATERIAL**" or "**CAUTION - RADIATION AREA.**" Radiation sources must not be in any room or location that has not been approved by the RSO.

2. CONTROLLED AREAS

All areas with greater than exempt quantities or concentrations of radioactive material present are controlled areas. Access to such an area must then be controlled by the Authorized User and limited to persons requiring access. Visitors in these areas must be escorted.

3. RADIATION LABORATORY RULES

Each laboratory using radionuclides shall conspicuously post the UNLV "General Radiation Laboratory Rules" (see Appendix D).

4. NOTICE TO EMPLOYEES

The State of Nevada Radiation Control Program Form NRC-1 "Notice to Employees" (NOTE: The "NRC" here means Nevada Radiation Control, not U.S. Nuclear Regulatory Commission) shall be conspicuously posted in each laboratory where radioactive materials are used (see Appendix E).

G. PROTECTIVE CLOTHING POLICY

Personnel working in designated areas displayed on lab maps (where unsealed radioactive materials are in use) must wear protective garments. Open toed shoes and sandals are not permitted. A laboratory coat, safety glasses, and disposable gloves are considered minimum fulfillment of this requirement. Additional protective garments may be required by the RSO.

H. STORAGE AND CONSUMPTION OF FOOD, SMOKING, AND APPLICATION OF COSMETICS POLICY

The storage and consumption of food, smoking, and application of cosmetics are prohibited in locations authorized for the storage and use of radioactive materials.

Upon the request of the Authorized User, "Clean Areas" may be posted by the Radiation Safety Office after a critical evaluation of the potential for maintaining the area free of radioactive contamination is conducted by the Radiation Safety Office. "Clean" areas in this section mean the absence of radioactive material or radiation sources. All designated "Clean Areas" will be surveyed for contamination whenever contamination is found in any adjacent work area.

Approval of the "Clean Area" will depend in part on the radioisotopes, amounts, and physical forms of the isotopes, as well as the types of operations being conducted.

Refrigerators used for storage of radioactive materials shall not be used for storage of food and beverages.

I. PERSONAL HYGIENE

Mouth pipetting is not permitted while working with radioactive materials. Personnel completing the manipulation of radioactive materials shall wash their hands thoroughly and monitor them for radiological contamination before leaving the laboratory.

J. GENERAL MONITORING

1. User Responsibilities

Immediately following use of radioactive materials in an area, a survey to ensure that radioactive material has not spread from the work area shall be conducted. The survey must be documented and a record of each survey retained within the facility. **Survey results shall be documented even though no contamination has been found.** Surveys

and their documentation may be required more frequently at the discretion of the RSO. If contamination is found, the AU must provide appropriate restriction to the area and promptly reduce the level of contamination to below the maximum permissible level specified for the area. The AU must inform the RSO of any persistent contamination. Each laboratory in which radioisotopes are used shall be equipped with a portable survey instrument(s) in good working order capable of detecting the type of radiation(s) emitted by the isotope(s) used. These instruments shall be continuously available for routine monitoring and for surveys following a radiation incident. Because these instruments usually are not capable of detecting H-3, swipe tests analysis by liquid scintillation counting are required when H-3 is used. All portable survey equipment will be calibrated, and all fixed counting instruments will have their efficiencies determined at intervals not to exceed one year and whenever repairs are completed. Documentation of such calibration or efficiency tests shall be maintained at the Radiation Safety Office.

2. Radiation Safety Office Responsibilities

The RSO and/or other qualified Radiation Safety Office personnel shall also conduct quarterly surveys (at least 4 times per year) of all areas in which licensed radioactive material is used, and will institute or recommend appropriate corrective measures in cases where contamination or other sources of potential hazard are found to exist. Radioactive sealed sources shall be tested for leakage in accordance with NAC 459.307.

V: ANIMAL USE POLICY

A. CAGING AND LABELING

Small animals given radioactive materials shall be caged separately from non-radioactive animals. Cages shall be labeled with appropriate radiation warning signs. Information on the label shall include the name of the person responsible for the experiment, the radioisotope, quantity, and date of administration. Special arrangements through the Radiation Safety Officer must be made prior to administering radioactive materials to large animals. Animals that receive radioisotopes and are not humanely killed at the termination of the program must be properly identified and controlled. Approval of the Radiation Safety Office will be required prior to relocation of any such animal.

B. CONTAMINATION CONTROL

Radioactive excreta, animal carcasses and tissues, contaminated cage bedding, etc., are handled in accordance with radioactive waste disposal procedures. Projects likely to produce large quantities of waste or involving unusual contamination potentials will be reviewed by the RSO, on a case by case basis, prior to the start of work, to assure that facilities to be used are adequate.

C. INSTRUCTION OF ANIMAL CARE PROVIDERS

The Authorized User is responsible for assuring that animal care providers and handlers are given the RSO approved written instructions pertaining to radiation protection issues. This is to ensure that these personnel are trained to deal with any potential hazards they may encounter in providing care and/or cleaning for the laboratory animal facilities. Copies of these written instructions will be posted in the Laboratory Animal Care Facility and will be kept on file in the Radiation Safety Office.

SECTION 2: PROCEDURES

I. RADIATION USE AUTHORIZATION

Before an individual may use radioactive sources for purposes of teaching, research, etc., an RUA application **must be submitted to the RSO for approval by the RSC**. NO RADIOISOTOPES MAY BE ORDERED OR USED UNTIL THE RUA APPLICATION IS APPROVED. The applicant must provide all information requested on the RSO Form 18.

A. DEFINITION

An RUA is a written approval from the **RSC** to an individual for the purpose of ordering, purchasing, possessing and using radioisotopes. Application forms are available from the RMS webpage and in the Forms section (Appendix E) of this Manual.

B. QUALIFICATIONS

Faculty and staff members who are engaged as Principal Investigators and/or have significant responsibility for administrative, medical, academic or experimental functions involving radioactive materials/radiation and can fulfill the requirements in Section 1 (Policy) II.F of this Radiation Safety Manual may apply for an RUA.

C. RESPONSIBILITIES AND REQUIREMENTS OF AUTHORIZED USERS

The Authorized User is responsible for the safe use of the radiation source(s), STRICT compliance with the contents of this Manual and the provisions and requirements of NAC 459.010-950, inclusive, and the University radioactive materials license. The AU must ensure that all persons working under his/her supervision have received proper training and are aware of the radiation hazards associated with their activities. The Authorized User must also ensure that these persons observe the guidelines and procedures set forth in the UNLV Radiation Safety Manual.

- a. A mechanism to assist with this goal is the development and use of a research protocol, which includes the Radiation Risk Assessment (RRA).
- b. The AU will monitor researcher's lab practices for conformance with an applicable and approved protocol.

- c. These protocols will be effective one year from the date of approval, and will require re-submittal for signature and approval.

D. REQUIRED INFORMATION

1. Name of Principal Investigator, or Program Director, his/her Department and telephone number.
2. Applicant's radiation training and experience.
3. Nature of source of ionizing radiation.
4. Isotope(s), amount(s), and form(s) proposed for the experiment or project. If the amount desired will cause the University to exceed the amount specified in UNLV's radioactive material license the time required for approval will be longer because a License amendment will have to be requested from the State in order to proceed with the authorization approval process.
5. General nature of experimental or teaching protocols and gross hazard evaluation of the experiment or project.
6. Anticipated radiation levels and allowed surface contamination in lab area(s).
7. Proposed monitoring instruments/procedures to be used. Contact the RSO for recommendations for monitoring instrumentation if in doubt.
8. Proposed radioactive waste handling/disposal protocols.
9. Location: building name, room number, department in which radioactive materials will be used.
10. Ventilation: Hoods, glove boxes/or similar devices. Indicate air handling capacities, filters (if any), etc.
11. Radiological protection equipment to be used: e.g., shielding, waste receptacles, trays, absorbent paper, remote-manipulators, etc.
12. Building plan for proposed use location (partial): drawings (plan view) showing hood and exhaust run location, lab bench and sink locations, adjacent rooms, exterior wall(s), hallways and windows, ceiling height, floor and wall construction shall be stated.
13. Occupancy of area: i.e., does the area require access restrictions? If so, list the occupancy of any other personnel working in the same area and in any adjacent rooms and hallways (above and below also).
14. Written department approval to apply for the use of radioactive materials.

E. APPROVAL OF THE RUA APPLICATION

Completed applications shall be submitted to the **RSO for approval by the RSC.**

- a. The RSO will review RUA's biennially and recommend these for renewal/approval by the RSC. As part of this review, the RUA and associated protocol(s) will be evaluated to ensure accurate reflection of the work being performed, as described in these documents.
- b. Approved RUAs will be effective for two years from the date of approval, at the end of which they must again be resubmitted for review and approval by the RSC.

NOTE: Notification of review decisions will be sent to the applicant and the appropriate Department Head.

II. RADIOACTIVE MATERIALS USE AND CONTROL

It is the responsibility of all users of radiation sources at UNLV to comply with applicable Federal, State, and the University requirements specified in this manual, any limitations imposed by the **RSC** on a User's authorization, and specifically the control procedures outlined in this section.

A. PROCUREMENT PROCEDURE

ALL RADIOACTIVE MATERIALS ACQUISITION MUST BE APPROVED BY THE RSO. Authorized Users must make arrangements with the Radiation Safety Office and the Purchasing Department prior to need.

An AU desiring to purchase radioactive materials or ionizing radiation sources must receive approval from the Radiation Safety Office. This ensures compliance with License requirements, proper documentation of the material, and direct communication between the prospective user and the Radiation Safety Office. A formal arrangement between the Purchasing Department and the Radiation Safety Office (no radioactive materials or ionizing radiation sources, including "Exempt quantities," will be purchased without the RSO approval) exists to help prevent the accidental purchase and use of such materials by persons not familiar with the requirements of this Radiation Safety Manual.

B. SOURCES RECEIVED UNDER THE SERVICE LICENSE

Radiation sources (including samples for analysis) received under the Service License may be received at the Health Physics Lab (HPL). Individuals receiving these materials must be properly trained in radiation safety and control, and the applicable Department of Transportation (DOT) regulations, with appropriate certificates on file in the facility. The materials and and/or samples must be received according to NAC 459.3585, and documentation of the receipt must be maintained. The RSO must be notified immediately of any concerns or anomalies regarding the samples.

C. RECEIPT PROCEDURE

Radiation sources are received at UNLV Receiving. The personnel at Receiving will immediately notify the RSO of the receipt. Radiation Safety Staff will check the package for contamination and radiation levels as soon as practicable after receipt, but no later than 3 hours after the package is received if received during normal working hours. If the package is not received during normal working hours, it will be surveyed and swiped not later than 3 hours after the beginning of the next working day. (There is a secure storage area in Receiving for sources awaiting the Radiation Safety Office pickup.)

Radiation source shipments will not be accepted during off duty hours unless special arrangements are made with the RSO prior to receipt of the shipment.

1. RECEIVING PERSONNEL ARE RESPONSIBLE FOR:

- a. Inspecting packages that have the radiation insignia, are labeled "radioactive materials," or are shipped by a company that manufactures radiation sources IMMEDIATELY upon receipt. Limited quantity shipments may not have "radioactive" markings or labeling on the outside of the package, but the Radiation Safety Office will attempt to coordinate these shipments. Any evidence of damage (e.g. leaking of contents) must be brought to the immediate attention of the RSO.
- b. Not accepting damaged packages(s), i.e., leaking or torn: Detain driver and call the RSO (895-4226) immediately.
- c. Placing packages in designated storage area.
- d. Notifying the RSO at 895-4226.
- e. Releasing radioactive material shipments only to the RSO or designee.

2. RADIATION SAFETY OFFICE PERSONNEL ARE RESPONSIBLE FOR:

- a. Removing packages from Receiving and transporting them to the Radiation Protection Laboratory (RPL).
- b. Monitoring packages for external radiation levels using appropriate instrument(s).
 - i. Check the dose rate at one meter from the package. The dose rate must be less than or equal to the dose rate represented by the transport index on the shipment label.
 - ii. Check the dose rate at surface of package.
 - iii. If the dose rate is higher than 20% of maximum value indicated on the shipment paperwork, secure source and contact the Radiation Safety Officer immediately.
- c. Wipe testing external surfaces of the packages for removable contamination.

- d. Opening outer packages and removing packing slips. Opening inner packages and verifying that the contents agree in name and quantity with the packing slips and the amount in the original purchase order.
- e. Measuring radiation levels of containers.
NOTE: Utilize shielding material and remote handling tools where appropriate.
- f. Checking for possible breakage of seals on containers, loss of liquid, or change in color of absorbing materials.
- g. Wipe testing inner contents and documenting findings on the appropriate form.
NOTE: The liner, shield, and isotope container may have surface contamination; if contaminated, they should be discarded in appropriate radioactive waste disposal containers and the AU informed.
- h. Notifying the vendor(s) immediately if beta or gamma contamination in excess of 2200dpm/100 sq. cm. or alpha contamination in excess of 220dpm/100 sq. cm. is detected on any surface, or discrepancies in the amount received as compared to the amount ordered are observed.
NOTE: The package must be placed in another container in a secure location until disposition is determined.
- i. Notifying the Authorized Users and delivering all packages following Radiation Safety Office inspection.

Upon completion of this receipt procedure, the Authorized User will be notified and arrangements will be made to deliver the material to their lab or provide storage for the material for future delivery. **The Radiation Safety Office will only deliver RAM packages to the Authorized User's approved RAM use/storage location.**

D. SOURCES RECEIVED GRATIS

When the procurement procedure does not involve the Purchasing Department the following procedures must be followed:

1. Individuals obtaining radioactive materials gratis must notify and request permission and instructions from the RSO.
2. The RSO must determine and certify that this acquisition will not cause the user to possess any radionuclide in any amount exceeding his/her authorized quantity.
3. The isotopes must be received by the Radiation Safety Office staff in accordance with the provisions of the previous section.

E. TRANSFER PROCEDURE

The Authorized User must receive approval in writing from the Radiation Safety Officer prior to transfer of isotopes to any other Authorized User. In all situations, radiation exposure levels during transfer, use, and storage shall meet the exposure limits specified in Section 1, III of this manual.

Advice and assistance will be provided for all shipments of radioactive materials from and to UNLV. The RSO must be informed when radioactive material is shipped from and to UNLV. All shipments must receive prior WRITTEN approval from the Radiation Safety Office. Questions concerning transportation and packaging should be referred to the Radiation Safety Office.

F. INVENTORY OF RADIOACTIVE MATERIALS

In order to maintain proper control of radioactive materials and to meet the License requirements, it is necessary to compile semiannual (not exceeding a six months period) inventories of all radioactive materials. Inventory reports shall be submitted and filed at the Radiation Safety Office.

THIS INVENTORY MUST INCLUDE THE FOLLOWING INFORMATION:

- Source identification/serial number;
- Physical location of source – building, room number and location in the room;
- Source description – radionuclide name – sealed/unsealed;
- Original activity or radiation emission and date;
- Current activity as of the date of the inventory;
- Percent of material remaining;
- Date and name of person performing the inventory.

The Radiation Safety Office will provide every AU with the inventory report form. A semiannual physical inventory report shall be submitted to the RSO. All completed inventory forms must bear an original signature and date. If there are no radioactive materials held by an AU, a blank and signed inventory form shall still be submitted to indicate so. Failure to submit the required inventories when due will result in immediate suspension of the AU's Authorization until such time as the AU convinces the RSO that all sources are accounted for and appropriate procedures are in place to prevent such problems from recurring.

G. LABELING OF RADIATION SOURCES

Each licensed radiation source or container shall be labeled with an identification tag bearing the words "Caution Radioactive Material" and further labeled in accordance with NAC 459.357-3575, inclusive. Original containers, stock solutions, and larger transfer containers shall be labeled with the radioisotope(s), quantity and date at a minimum. All tags or labels shall be removed/replaced when the information on them is no longer applicable.

H. USE OF RADIATION SOURCES

1. SEALED SOURCE USE PROCEDURE

In the use of sealed sources the primary safety consideration is to control external radiation exposure to the human body from gamma rays and neutrons. A secondary consideration is to prevent contamination and exposure if a sealed source should leak.

1. Remote handling equipment appropriate to the source shall be used if the radiation exposure one inch from the surface is greater than 10 mrem/hr. For long periods of handling (greater than one hour) remote equipment should be used to keep dose rates low. Shielding shall be used whenever possible to further reduce personnel exposure.
2. Personnel monitoring equipment (badges and dosimeters) is provided by the Radiation Safety Office and shall be used if an individual is likely to receive a dose in excess of 10% of the applicable value specified in NAC 459.325.
3. Radiation surveys sufficient to demonstrate compliance with NAC 459.335, regarding compliance with dose limits for individual member of general public, shall be made near the areas where radioactive materials used or stored. Records of these surveys shall be maintained by the Radiation safety Office.
4. The use area shall be posted with the appropriate caution signs as specified in NAC 459.355-3575.
5. The State of Nevada Radiation Control Program Form NRC-1 "Notice to Employees" shall be posted.
6. Sources must be secured from unauthorized access or be attended at all times.
7. Leak testing of each sealed source not exempt from licensing shall be performed in accordance with NAC 459.307.
8. Notify the Radiation Safety Office immediately if a sealed source is lost or damaged, found to be leaking, or used in such a manner that human exposure above 100 mrem is a possibility.
9. If a source is found to be leaking (0.005 μ Ci or more of removable contamination), the Radiation Safety Staff will remove the source from use and

place it in locked storage. The State of Nevada Radiation Control Program will be immediately notified, and a report will be filed with within 5 days (NAC 459.307). Follow-up surveys will be conducted to determine the degree of contamination spread. Action will be taken to minimize personnel and property contamination. Documentation of the resolution of all leaks shall be maintained by the Radiation Safety Office.

NOTE: Any leakage or suspected leakage of sealed sources shall be reported immediately to Radiation Safety Office.

2. UNSEALED (OPEN) SOURCE USE PROCEDURES

1. All users are considered to be Radiation Workers and must be properly trained: inexperienced workers should not work alone. Whenever possible a preliminary experiment with inactive materials should be carried out before a new procedure is attempted, to identify possible handling difficulties.
2. The experimenter (Radiation Worker) will be required to produce a specific protocol that shall include an RRA if a project involves the use of radioactive unsealed (open) sources. An RRA shall be undertaken with the assistance of the AU and RSO.
3. Eating, drinking, smoking, or application of cosmetics etc., are not permitted in areas where radioactive materials are handled. No food, drink, crockery, or cutlery should be brought into such areas.
4. No mouth operated equipment (e.g. pipettes) may be used. Self-adhesive, not gummed, labels should be used.
5. A laboratory coat or overall must be worn for all work with unsealed radioactive materials. In certain circumstances the RSO may, in consultation with the AU, prescribe more stringent safety measures such as special safety clothing and changing facilities.
6. Disposable surgical gloves, or equivalent, must be worn when there is a possibility of hands becoming contaminated. Gloves should be checked for contamination before handling switches, taps, monitoring instruments etc.
7. Any cut or break in the skin of the hands or other vulnerable area liable to contamination must be covered with a waterproof adhesive dressing before entering the radiation laboratory. Any injury received during work with radioactive materials must be reported to the RSO who will arrange suitable first-aid. If any significant intake of radioactivity or excessive skin contamination is suspected, the RSO shall be informed immediately and appropriate remedial action commenced.
8. A comprehensive standard of cleanliness must be maintained to avoid spread of contamination. Working areas should be kept free of articles not required for the

work. Each worker must be responsible for tidying up after him/herself at the end of each working session.

9. Personal dosimeters (body badges and/or extremity dosimeters) must be worn if issued by the RSO.
10. Each consignment of radioactive material must be checked for leakage of radioactivity during transit, by monitoring packing materials.
11. Radioactive solutions should always be handled over a suitable tray lined with absorbent paper or a disposable liner.
12. Shielding and handling equipment (e.g. forceps etc.) should be used as appropriate. For accurately transferring small volumes of liquid a disposable-tip, automatic pipette is recommended. RAM work areas shall be clearly posted and dose rates should be maintained ALARA.
13. Radioactive solutions should be manipulated behind a splash barrier. All procedures that are considered likely to produce vapor, spray, dust or radioactive gas must be carried out in an approved fume hood, glove box or safety cabinet.
14. If a hypodermic needle is to be used to dispense from a multidose vial, care should be taken to avoid aerosols/splashing due to pressure build up. Cooling the vial before puncturing the rubber septum should ensure that the pressure inside is less than atmospheric.
15. All radioactively contaminated waste must be segregated and disposed of in accordance with the radioactive waste procedure.
16. Laboratory sinks shall not be used for disposal or storage of radioactive material.
17. All radioactive samples must be clearly labeled, in appropriate containers, and securely stored.
18. All items used within a RAM work area must be labeled with radioactive material contamination warning tape. Tape can be removed from equipment only if a contamination check is clear and the equipment is to be removed from the area.
19. Accurate records must be kept of all receipts, current stock and waste disposals. Changes made to records must be clear, concise and not obliterate the error, and contain or reference an explanation for the change.
20. Monitoring of the work area should be carried out at the end of each work session. No item may be removed from the radioisotope area until it has been monitored and found to be free of contamination.
21. A full area monitoring survey should be undertaken on regular basis and written records kept of all results, even if no contamination is found. Frequency of the survey shall be determined during the RRA with the assistance of the RSO.
22. Potential radiation hazards should be assessed and, if necessary, contingency plans drawn up for use in an emergency. In the event of any such incident the RSO must be informed immediately.

I. STORAGE OF RADIOACTIVE MATERIALS

All radioactive materials must be stored in a secure location (restricted access, minimum fire hazard, approved ventilation, sufficient shielding), labeled, and the location posted with a "Caution Radioactive Material" sign. The Radiation Safety Office will provide the proper signs and surveys to ensure compliance with the posting requirements of NAC 459.355-3575.

1. Materials that could release airborne radioactive material must be stored in an approved fume hood or glove box.
2. Storage procedures for radioactive materials shall be provided by the User and approved by Radiation Safety Office.
3. Radiation materials must be stored in a secured area with access controlled by the User. Radiation levels in any "Uncontrolled" area must be less than 2 mrem/hr and 100 mrem/yr. The User is responsible for obtaining any shielding needed to satisfy these requirements.
4. Radiation source storage areas and containers shall be marked with signs and labels in accordance with NAC 459.3555-3575.
5. Quarterly radiation surveys of the storage area shall be made by Radiation Safety Staff. A record of these surveys will be provided to the appropriate Authorized User and kept on file in the Radiation Safety Office.
6. Changing storage areas must be approved in advance by the RSO. Temporary storage at another University site for up to 24 hours is allowed if approved in advance by the RSO and the source is secured against unauthorized removal and radiation levels in uncontrolled areas are below 2 mrem/hr.
7. Use adequate shielding. Exposure Rate must not exceed 2 mrem/hr. Make sure bench top (if used) will support the weight of a shield and that shielding materials are secured so they will not topple or fall.
8. Provide a pan and absorbent pad to catch spillage.
9. Clearly identify each item in storage, use a mirror or transparent portion of shield to provide for visual inspection without exposure, if applicable. Provide a sketch of the storage layout showing where items are stored, or a written description of the item and its location.
10. Compartmentalized shielding (use partitions or smaller shipping shields) will reduce exposure to the aggregate of the materials.
11. Use a plastic box or other secondary container for items in storage in refrigerators and freezers.
12. Do not store food or beverages in areas (including refrigerator) where radioactive materials are stored.
13. Locate appropriate handling tools and supplies (automatic pipette, tongs, gloves, etc.) conveniently.

14. Store radioactive liquids in unbreakable containers or in secondary containers to prevent spillage.
15. Shield radioactive wastes in storage, awaiting pickup, so that radiation levels at 30 cm from the surface do not exceed 2 mrem/hr.

J. RADIOACTIVE WASTE PICK-UP AND DISPOSAL

1. DISPOSAL OF RADIOACTIVE MATERIALS

All radioactive materials must be disposed of in accordance with procedures established by the **RSC**. The users shall contact the Radiation Safety Office for disposal of radioactive material. The RSO shall provide instructions for storage of small quantities of waste in user laboratories and shall arrange for pick-up of such materials.

2. AUTHORIZED USER RESPONSIBILITIES

The Authorized User must label waste containers as to their content and keep a record of the waste he/she generates (reasonable estimates of the activity are acceptable).

1. THE FOLLOWING MUST BE OBSERVED:

- a. Radioactive materials may not be disposed of via the sanitary waste system by the User or his/her assistants.
 - b. Incineration of radioactive waste at UNLV is prohibited.
 - c. Radioactive labels or signs or tapes must not be placed in P-32 or S-35 radioactive waste.
 - d. Short half life radioactive waste ($T_{1/2}$ Less than 120 days) and long half life radioactive waste must be separated.
 - e. When waste containers are full, perform radiation surveys and swipe outside surface for contamination. If contamination is found, decontaminate the affected areas.
2. Advice on storage containers and short term (<2 weeks) storage locations will be provided by the Radiation Safety Staff.
 3. The Radiation Safety Office will not pick-up improper and unsafely packaged radioactive waste.

NOTE: Close but do not seal the container if the waste may be held for decay in storage, so that it can be inspected by the Radiation Safety Office staff.

3. RADIATION SAFETY OFFICE RESPONSIBILITIES

Radioactive waste can be disposed of only by the Radiation Safety Office in a manner that has been specifically approved by the RSO. All packaging for final disposal will be accomplished by the Radiation Safety Office.

In the laboratory, separate liquid and dry wastes and handle according to the following procedures:

1. Label all waste "CAUTION - RADIOACTIVE MATERIAL", with the legal symbol, and record the following information on the log sheet provided with each container.
 1. Name of Authorized User.
 2. Identity of Isotope.
 3. Amount of isotope in milliCuries or microCuries.
 4. Date material is placed in container.
 5. Notation of any presence of any other hazardous materials.
2. All solid, absorbed liquid, scintillation vials and/or animal carcasses must be packaged in the manner outlined as follows:

a. Packaging of Dry Solid Radioactive Waste

(Paper towels, hand gloves, syringes, empty bottles, clothing, etc.):

1. Dry, solid radioactive waste shall be placed in special containers, approved by the RSO. Toxic substances and biohazards must be deactivated using procedures approved by the **RSC** before disposal.
2. In the case of short-lived radioactive materials (half-life shorter than 120 days, no radioactive material labels are to be placed inside of waste barrel.
3. Container must be lined with a plastic liner approved by the RSO.
4. No syringes or other sharp objects are to be placed directly into the waste container that could puncture the plastic liner. The objects must be placed in an approved secondary "sharps" container prior to disposal.
5. Separate short ($T_{1/2}$ less than 120 days) and long lived RAM waste.
6. Put only contaminated articles in the RAM waste barrel.
7. Log all entries on the waste log.

b. Packaging of Liquid Scintillation Vials

Organic solvents are not allowed to be mixed with radioactive material. Biodegradable non-hazardous liquid scintillation solutions are allowed. The following procedure shall be followed:

1. Container must be approved by the RSO.
2. Container must be lined with a plastic liner approved by the RSO and sealed at the top when container is packed.
3. Vials are not to be opened and should be checked for loose caps prior to being deposited in the waste barrel. Do not dispose of non-radioactive vials in the waste barrel.
4. Log all deposits in waste container on the waste log.

c. Packaging of Radioactive Animal Carcasses

Radioactive animal carcasses or other biological material must be sealed, frozen and labeled similar to the other types of waste and disposed in accordance with the following procedures:

1. Container must meet DOT requirements. The final package will be a double-walled metal container, i.e., a 30 gallon drum in a 55 gallon drum.
2. Line 30 gallon drum with 4 mil plastic liner.
3. Place animal carcasses into 30 gallon drum with absorbent and lime. Ratio one part lime to ten parts absorbent.
4. Seal plastic liner and 30 gallon drum.
5. Place 3" of absorbent in bottom of 55 gallon drum.
6. Place 30 gallon metal drum inside the 55 gallon drum.
7. Place absorbent between walls of 30 gallon drum and 55 gallon drum.
8. Install gasket to make package free of defects and seal 55 gallon drum.
9. Log all entries on the waste log (RSO Form-3).
10. Use only approved absorbents by the Radiation Safety Office.

4. UNUSUAL RADIOACTIVE WASTE DISPOSAL PROBLEMS

Cases where radioactive waste cannot be disposed of as outlined above must be referred to the Radiation Safety Office.

III. RADIATION AND CONTAMINATION CONTROL

A. INTRODUCTION

The possibility of radioactive contamination can be reduced by using proper handling techniques, the use of adequate protective clothing, and the use of sealed containers for transfer and storage of material. THE FOLLOWING STEPS WILL HELP TO PREVENT CONTAMINATION:

- A. All areas in which contamination is possible must be posted accordingly.
- B. Protective clothing will be:
 - 1. specified in the RUA application,
 - 2. provided by the user responsible, and
 - 3. worn by all individuals working in the area
- C. Swipe tests will be taken to evaluate the level of removable contamination according to procedure.
- D. Volatile radioactive compounds will be stored in sealed containers.
- E. Smoking, eating, drinking, and application of cosmetics is prohibited in areas where radioactive materials are used or stored.
- F. Leak tests will be performed on sealed sources according to the RSO guidance.

NOTE: Failure to follow the requirements above will result in enforcement action.

While research programs rely on the RSO's advice for accident prevention, correct experimental design and radiation protection procedures, and a conscientious radiation survey program is necessary to maintain awareness of possible radiation hazards.

B. AUTHORIZED USERS RESPONSIBILITIES

It is the responsibility of the Authorized User to perform the following duties:

- 1. Appropriate radiation and smear surveys in areas where radiation or radioactive contamination may exist.
 - A. Procedures/facilities involving a high potential for contamination/radiation to be present will be surveyed by the Authorized User or his/her associate during or immediately following radioactive material/radiation use.
 - B. These surveys must be documented whenever the area has been in use.

2. Individual users are required to obtain suitable equipment for their own monitoring needs as a general policy.

The RSO will advise the Authorized Users in the selection and correct use of their instrumentation. The Radiation Safety Staff will provide calibration for commonly used instruments (i.e., ion chambers and Geiger counters) and will assist the Authorized User in obtaining calibration services for the less commonly used instruments.

NOTE: Improper use of instruments may lead to misinterpretation of the hazards. This could result in excessive/unnecessary radiation exposures.

3. For Rad Safety Levels 1 and 2, (according to Form 6a, “RRA and Control Guideline”) Authorized Users are required to provide instruction to Workers on radiological risks and proper handling procedures for RAM with lab specific training followed by routine supervision, and in-procedure monitoring.
4. For Rad Safety Level 3, in addition to the duties described for Rad Levels 1 and 2, Authorized Users are required to provide appropriate intermittent supervision while Rad Level 3 work is performed.
 - a. Intermittent supervision is defined as at a minimum physically being in the lab twice per day where Rad Level 3 work is performed.
 - b. Additionally, the AU will be available for consultation and emergency response, if necessary.
5. For Rad Safety Level 4, in addition to the duties described for Rad Levels 1 through 3, Authorized Users are required to provide direct, uninterrupted supervision while Rad Level 4 work is performed.

1. CONTAMINATION SURVEYS

The most effective method for evaluating an area for removable contamination is to measure the activity collected on smears of the work area, adjacent areas, floors, etc. using appropriate wipes or filter papers. The smears are then counted in an appropriate detection system, (e.g., for H-3 or C-14 a Liquid Scintillation Counter is used). If contamination is found, appropriate restriction to the area shall be provided and actions to promptly reduce the level of contamination to below the maximum permissible level specified for the area shall be taken. All findings, actions taken to decontaminate and the final swipe test results must be documented. Contact the Radiation Safety Office if contamination persists.

2. RADIATION SURVEYS

Personnel in the areas with moderate to high energy beta emitters (>0.1MeV) and x-ray or gamma emitters must use an appropriate radiation detection instrument to ensure radiation exposures are being adequately controlled. Use a map of the facility and record

the readings from the radiation survey meter in the location on the map. Also include surveyor, date, building and room number, instrument and probe used (model and serial numbers), instrument calibration date and any information regarding the survey. This must be available for inspection. Radiation levels must be AS LOW AS REASONABLY ACHIEVABLE in the radioactive material use facility and must not create a radiation area in any other areas such as hallways, rooms next to and directly above and below (except designated radiation areas).

C. RADIATION SAFETY STAFF RESPONSIBILITIES

The Radiation Safety Staff will conduct inspections of radioactive materials laboratories monthly. RSO Form 5 will be used for inspections and will become the written report that will be placed on file in the Radiation Safety Office.

The Radiation Safety Staff will conduct appropriate radiation and/or contamination (smear) surveys within each laboratory/facility at intervals of at least every 3 months. The routine (quarterly, area) surveys will include a site visit to assure that all provisions of this Radiation Safety Manual are complied with and that radiation and surface contamination levels are within the UNLV Administrative Limits.

D: SEALED SOURCE LEAK TESTING

1. DEFINITION OF SEALED SOURCE

A sealed source means radioactive material that is permanently bonded or fixed in a capsule or matrix designed to prevent release and dispersal of the radioactive material under the most severe conditions that are likely to be encountered in normal use and handling.

2. GENERAL REQUIREMENTS

The Radiation Safety Office is responsible for ensuring that all sealed sources other than hydrogen-3 in gaseous form, with a half-life greater than 30 days are leak tested. Sealed sources must be tested for contamination in accordance with NAC 459.307. If there is a reason to suspect that a source might be damaged, it shall be tested before further use. Contamination and leak tests must be capable of determining the presence of 0.005 microCurie of removable contamination.

3. EXEMPTIONS

No leak test is required when:

1. The source contains 100 microCuries or less of beta or gamma emitting material or 10 microCuries or less of alpha emitting materials; or
2. Sealed sources are in storage and not being used; sources must be tested for leakage prior to use or transfer unless they have been leak tested within 6 months prior to the date of use or transfer. Documentation must be maintained to indicate when the source was placed in, and removed from, storage.

4. PROCEDURE

The leak test may be performed in the following manner:

1. The Authorized User performs the test according to instructions provided by the manufacturer and notifies the RSO in writing of the results, providing a copy of documentation of test results.
2. The Authorized User performs the leak test according to instructions of the manufacturer of the device. He/she then sends the wipe to the RSO for analysis. The RSO will then send a written report to the Authorized User for his/her files.
3. The RSO may make arrangements for the Radiation Safety Staff to perform both the wipe and the analysis. The RSO will maintain a leak test certificate on file in the Radiation Safety Office. A copy will be provided to the Authorized User if required for transportation purposes.

If the leak test reveals the presence of 0.005 microCuries or more of removable contamination contact the Radiation Safety Office **IMMEDIATELY**. The RSO shall immediately inform the State of Nevada Radiation Control Program by telephone, withdraw the sealed source, or the device in which it is permanently mounted, and place it in locked storage. A verbal notification and/or written report shall be filed with the State of Nevada Radiation Control Program according to NAC 459.307.

E. REPORTING OF SURVEY FINDINGS

1. A copy of all survey reports completed by the Radiation Safety Office will be sent to the appropriate Authorized User. Situations requiring immediate action, such as removable contamination above the maximum permissible level specified for the area will be reported by telephone.

2. Each survey report is reviewed by the RSO and will include, if appropriate, findings, corrective measures to be taken by the User and the time allotted to accomplish the corrective measures.
3. Authorized Users will maintain a separate file of survey reports for each area where they use radioactive material, e.g., each posted laboratory and storage area.

F. INSTRUMENTATION AND EQUIPMENT

1. RADIATION DETECTION EQUIPMENT

Authorized Users must equip their laboratories with the appropriate survey instruments for each radioactive material that they use in their laboratories/facilities.

The Radiation Safety Staff is responsible for performing, or having performed, all portable instrument calibrations. The Authorized User is responsible for performing operability and, when appropriate, efficiency checks on the equipment in their facilities/laboratories. All radiation detection equipment in use must be calibrated annually. Equipment out of calibration must be clearly labeled as such.

GM and beta scintillation detectors are useful for monitoring medium-to-high energy beta radiation. These detectors are not capable of quantifying H-3 activity due to the low energy of the beta emission from H-3. Liquid Scintillation Counters are used to evaluate smears or samples for H-3 content

Commonly used RAM at UNLV

Radionuclide (Est. activity)	Radioactive half-life	Radiation type, energy level	Exposure rate at 1 foot from point source without shield	Shielding requirement
H-3	12.3 years	Beta, low	Low	None
C-14	5730 years	Beta, medium	Low	None
P-32 (microCi)	14.3 days	Beta, high	300 mrad/hr	Plexiglas or equivalent
S-35	87 days	Beta, medium	Low	Plexiglas
Tc-99 (milliCi)	213,000 years	Beta, medium	Low	None
U-238	4.47 E9	Alpha, low	Low	Lead
Th-232	1.41 E10 yrs	Alpha, low	Low	Lead
Tc-99m	6.01 hrs	Gamma & x-ray, low	0.8 mR/hr	Lead, leaded glass or plastic
P-33, (microCi)	25.3 days	Beta, medium	2.4 mR/hr	Plexiglas or lead

Detectors and their applications

Detector type	Radiation to detect			Radionuclides	Portability
	α	β	x-ray & γ		
GM, metal cylinder		Yes	Yes	P-32, Cr-51, Sc-46, I-131	Yes
GM, pancake	Yes	Yes	Yes	Most RAMs used at UNLV except H-3, Ni-63	Yes
GM, Thin end	Yes	Yes	Yes	Most RAMs used at UNLV except H-3, Ni-63	Yes
Beta scintillation		Yes		C-14, P-32, P-33, S-35, CS-137, Co-60	yes
Beta-gamma scintillation		Yes	Yes	C-14, P-32, P-33, S-35, CS-137, Sc-46, Cr-51, I-125, I-131	yes
Ion chamber			Yes	Gamma and x-ray, (beta if equipped): exposure rate	Yes
Liquid scintillation analyzer	Yes	Yes	Yes	All RAM used at UNLV including H-3, C-14, Ni-63	Fixed
Gas Flow Proportional counter	Yes	Yes	Yes	Most RAM used at UNLV except H-3, Ni-63	Fixed

Nominal Efficiencies of Commonly Used Radiation Detectors (these are not absolute efficiencies)



Pancake GM

(^{14}C – 5%, ^{32}P – 32%, alpha – 15 %)



Thin end window GM

(^{14}C – 2%, ^{32}P – 15%, alpha – 7%)



Beta & Low Energy Gamma Scintillation Detector

(^{14}C – 5~10%, ^{32}P – 28%, ^{125}I – 19%)

IV. PERSONNEL MONITORING

Personal monitoring is required for persons who are likely to receive a dose in excess of 10% of Nevada State occupational dose limits.

A. HOW TO OBTAIN A DOSIMETER

Anyone who has received radiation safety training and who is likely to receive 10% of the State occupational dose limits will require personnel monitoring. The requesting personnel must complete RSO form 9 and send it to the Radiation Safety Office. Form 9 is attached in this Manual's form section and is also available from the RMS web page and office. It may take several days from request to dosimeter delivery. A spare dosimeter may be issued if warranted.

NOTE: Those AU's wishing to provide dosimetry to their students for class or laboratory activities must make special arrangements with the Radiation Safety Office.

B. DOSIMETER USE PROCEDURE

1. Dosimeters will be worn **ONLY** by the person to whom they are issued. They must **NOT** be loaned to another person nor used for area monitoring. (Badge(s) for the latter purposes are available from the Radiation Safety Office).
2. The whole body dosimeter should be worn as indicated on the badge or according to instructions by the RSO.
3. Ring dosimeters should be worn on the finger that is nearest the radiation source, usually the index finger, with the sensitive portion of the badge toward the radiation source.
4. Wear the badge whenever working with or around radiation sources, however, do not wear badges when undergoing medical or dental diagnosis or therapy, since your non-occupational dose(s) are not regulated by the State of Nevada Radiation Control Program, and are not to be included as part of your dosimetry results.
5. Use care when leaving the lab to place the dosimeter on the provided rack located in your lab so that badges are not left in exposure areas. If a badge is exposed in this manner, the dosimeter must be changed without delay since the dose should not be ascribed to the wearer. Return the badge to the RSO with an explanatory note.
6. The dosimeter must be placed on the designated dosimeter rack in the laboratory for periodic exchange. Delay in returning badges results in considerable extra work and correspondence in follow up. A badge that is returned late cannot be processed with the control dosimeter supplied with the shipment.

7. To prevent loss, badges should not normally be taken or removed from the facility or lab area.
8. The user must notify the RSO before undergoing any nuclear medicine studies or treatments, or before returning to work and wearing their dosimeter after such studies or treatment.
9. If the dosimeter assigned to an individual is lost or damaged, the RSO will evaluate the work performed by the individual since the last badge changeout and provide a determination of the appropriate dose to be assigned that individual. This evaluation will be documented and maintained as a dose record.

NOTE: A dosimeter must be processed immediately whenever serious exposure is suspected. Call the RSO if such circumstances arise.

C. DOSIMETRY RECORDS KEEPING

1. PERSONNEL EXPOSURE RECORDS

Results from processing of radiation monitoring devices and estimates of dose to personnel shall be part of the permanent records of the Radiation Safety Office. Upon written request by any wearer, the RSO will provide a copy of the individual's radiation exposure history. In any case where exposures of an individual to radiation must be reported to the State of Nevada Radiation Control Program pursuant to regulations, such individuals will be notified in writing of the nature and extent of their exposure within 5 working days from determination of the radiation exposure.

2. RECORDS OF PRIOR EXPOSURE

Employees or students requiring personal dosimetry will be required to complete RSO Form 9 indicating all locations where previous radiation exposures may have occurred within the calendar year. With the signed consent of the employee, a letter will be sent to the indicated facility or facilities requesting prior exposure history. Falsified statements or refusal to provide this information will result in denial of personal dosimetry and denial of permission to work in areas that require dosimetry.

D. INTERNAL DOSIMETRY

1.0 PURPOSE AND SCOPE

UNLV maintains an Internal Dosimetry Program, or Bioassay Program, the purpose of which is to assess inhaled, ingested, or absorbed radioactive materials in order to

determine internal dose to workers and to verify that radioactive material controls maintain internal exposures ALARA. This Program evaluates the need for bioassay and provides a rationale for the frequency and types of bioassay measurements necessary to ensure compliance with applicable regulations.

NAC Chapter 459 requires that each licensee monitor, to determine compliance with limits for occupational doses, the occupational intake of radioactive material by and assess the committed effective dose equivalent to adults who are likely to receive, in the course of one year, an intake in excess of ten percent of the annual applicable limit on intake in Columns I and II of Appendix B as defined in NAC 459.0192. Such monitoring is also important to assess possible uptakes during unusual events, or incidents, even if the employee is not anticipated to exceed ten per cent of the annual regulatory limit. In order to ensure compliance with the above, and in accord with established practices, the Radiological Safety Office will utilize as necessary measurements of concentrations of radioactive materials in the workplace obtained from air sampling, measurements of quantities of radioactive materials in the body, and/or measurements of quantities of radioactive materials excreted from the body, or any combination of these.

2.0 REGULATORY DRIVERS AND REFERENCES

To ensure an effective Internal Dosimetry program, UNLV shall comply with the following requirements of the NAC:

- a. NAC 459.325 - Limits on occupational doses for adults;
- b. NAC 459.3255 - Compliance with requirements for summation of external and internal doses;
- c. NAC 459.327 - Determination of external dose from airborne radioactive material;
- d. NAC 459.3255 - Compliance with requirements for summation of external and internal doses;
- e. NAC 459.3723 - Determination of compliance with limits for occupational doses.

The policy and procedures of the UNLV Internal Dosimetry Program are based upon the guidelines and recommendations of the following references:

- Regulatory Guide 8.9 - Acceptable Concepts, Models, Equations, and Assumptions for a Bioassay Program;
- Regulatory Guide 8.25 - Air Sampling In The Workplace;
- ANSI/HPS N13.39-2001 - Design of Internal Dosimetry Programs;
- NUREG 1400 - Air Sampling in the Workplace.

3.0 INTERNAL DOSIMETRY POLICY AND PROCEDURES

The RSO will assess each restricted area where unsealed sources are used to determine whether or not monitoring and/or bioassay is required and the frequency of such monitoring if it is required. This includes monitoring surface or removable contamination as well as air monitoring. As a general principle, bioassays will be required after any incident where the possibility of internal deposition of radioisotopes exists (e.g., contamination of personnel or real or suspected exposure of persons to airborne radioactivity). Bioassays might include such tests as radioanalysis of blood, urine, fecal samples, nose swabs, or of sputum. In addition the term bioassay includes whole body or thyroid counts. Bioassay service is available at any time upon the request of the User. Thyroid counts (which take only a few minutes) or other bioassays may be arranged by calling the RSO at 895-4226.

3.1 Responsibilities

Radiation Safety Committee (RSC) Responsibilities – The RSC is responsible for establishing policies for the Internal Dosimetry Program which conform to regulations and sound Health Physics principles.

Radiation Safety Officer (RSO) Responsibilities – The RSO is responsible **for the implementation** of the Internal Dosimetry Program and notification of personnel of the need for bioassay, shipping of samples, maintenance of bioassay records, and training of radiation workers and technical assistants who have actions associated with the Internal Dosimetry Program.

Authorized User (AU) Responsibilities – The AU is responsible for ensuring that all personnel assigned the task of working with radioactive materials are familiar with this policy/procedure and have access to a copy of this procedure. The AU shall ensure that personnel affected by the Internal Dosimetry Program are familiar with the requirements and procedures of the Program. The AU shall ensure all personnel requiring bioassay sampling provide samples in accordance with instructions and by the assigned date. Preservation and transfer of the bioassay samples to the RSO is also a responsibility of the AU.

3.2 Air Sampling Program

In keeping with the ALARA philosophy, UNLV uses engineering and administrative controls including training to minimize the possibility of RAM becoming airborne. Air sampling supported by personnel bioassay sampling at appropriate intervals is the principle monitoring method in the Internal Dosimetry Program. Air sampling may be used to determine the need for further bioassay, the adequacy of radiation protection controls, and to assess occupational dose to personnel. The following criteria shall apply to air monitoring at UNLV:

3.3 Air Monitoring Requirements

- a. Air monitoring shall be performed in all areas where there exists the potential to exceed 0.1 times any Derived Air Concentration (DAC) value.
- b. Weekly 24-hour air monitoring must be performed in labs using >0.01 Annual Limit on Intake (ALI) of dry, dispersible solids or volatile materials.
- c. Continuous air monitoring must be performed in labs using >0.1 ALI of dry, dispersible solids or volatile materials.
- d. A Breathing Zone air sample (BZA) must be taken if personnel are working with >1.0 ALI of dry dispersible or volatile material.
- e. RAD LEVEL 4 labs will require *both* continuous air monitoring and worker BZA sampling. RAD LEVEL 4 labs are defined in UNLV Form 22, "UNLV Risk Assessment and Control Guideline for Unsealed Radioactive Materials."

3.4 Air Sampling Assessment: Action Levels

When the air sampling media analysis indicates a positive result (greater than minimum detectable activity) the Radiation Safety Office will take action as follows:

- a. If the air sample activity is less than 0.05 times the DAC value listed in Appendix B of the NAC 459 (NAC 459.0192), no action is necessary.
- b. If the air sample activity is greater than 0.05, but less than 0.1 times the DAC, the RSO shall determine whether further investigation is necessary and whether or not personnel in the lab require further monitoring for occupational intake of radionuclide(s).
- c. If an air sample activity is greater than 0.1 times the DAC value, the RSO shall determine the source of the airborne contamination and evaluate the need for additional controls. The RSO shall also determine whether persons working in or frequenting the area during the sampling period require additional monitoring, and shall calculate an estimated number of DAC-hours received. If an intake is confirmed by bioassay, or must be assumed from the air sampling results, then the RSO shall assess the Committed Effective Dose Equivalent to the monitored person(s), and assign dose as required by regulations.
- d. Air samples analyzed for gross alpha/beta counts that identify concentration levels above UNLV's action level of 0.1 times the DAC of the isotope of concern, may require additional analyses.

3.5 Surface Contamination Assessment and Control.

Removable surface contamination may become airborne and thus be inhaled, ingested, or absorbed or otherwise introduced into the body. Hence the results of surveys may also indicate the need for air monitoring and/or bioassay. The following criteria shall apply to surface contamination used to determine the need for air monitoring/bioassay at UNLV.

When removable surface contamination is found during routine or non routine surveys:

- a. Action levels will depend on the location of the found contamination. For example, contamination in a work area in a hood or glovebox may require no action. Activity found on open workbenches, equipment, or floor surfaces may necessitate air sampling and/or bioassay.
- b. Surface contamination limits defining the Internal Dosimetry Action Level are listed in the table below, which gives values for the most frequently used unsealed radioisotopes. The limits represent 0.05% or less of the ALI and refer to the average number detected from a set of swipes collected from an area of contamination.

Isotope	Glove Box	Hood	Open Area
Gross Unkn alpha	2.22E+08 dpm	2.22E+06 dpm	2.22E+04 dpm
Gross Unkn beta	2.22E+09 dpm	2.22E+07 dpm	2.22E+05 dpm
H-3, C-14 (beta)	1.11E+12 dpm	1.11E+10 dpm	1.11E+08 dpm
Tc-99 (beta)	1.11E+10 dpm	1.11E+08 dpm	1.11E+06 dpm
U-233, 235, 238 (alpha)	4.44E+08 dpm	4.44E+06 dpm	4.44E+04 dpm
Np-237, Pu-239, Am-241(alpha)	1.11E+08 dpm	1.11E+06 dpm	1.11E+04 dpm

- c. If smear counts are less than the limits listed in the table above no action is necessary. However if smear counts exceed 50% of the limits, the RSO shall determine the source of surface contamination, whether or not proper work practices are being followed, and whether proper engineering controls are in place and functioning. The RSO may require air monitoring
- d. If smear activity is greater than the limits listed in the table above, persons working in or frequenting the area must be monitored for occupational intake of radionuclide(s) by air sampling and/or bioassay.

3.6 Quality Control

- a. Counting instruments (GFPC's, LSC's) used in surveys required by this procedure shall have current valid calibration.
- b. Air sampling instrumentation used in the sampling procedures shall be calibrated annually.
- c. This program shall be reviewed in the Annual Report to verify compliance with license conditions.

3.7 Record Keeping

- a. All records resulting from the Bioassay Program will be maintained and controlled in accordance with UNLV dosimetry policy and all applicable regulations.

- b. All records of exposure, internal and external, must be kept confidential, and reports furnished as required by regulations.

3.8 Bioassay Samples Collection and Analyses

Analyses of the bioassay samples shall be performed by a certified laboratory licensed by the NRC or an Agreement State. Samples shall be collected in the containers provided by the laboratory containers, and preserved, packaged, and shipped according to the laboratory instructions. The bioassay samples shall be used only for determination of internal radioactive materials.

3.9 Routine Bioassay Procedure

- a. Routine urine analyses may be conducted on personnel who work with radioactive materials in order to verify that radiation protection program controls protect individuals working with radioactive materials from inhalation of airborne radioactive material and ingestion or absorption of radioactive materials on surfaces.
- b. New students and researchers working in Rad Level 3 or 4 labs (as described in the “UNLV Risk Assessment and Control Guideline for Radioactive Materials”) will be required to provide a baseline bioassay sample. These baseline samples will be collected and analyzed once the new researcher’s project and radioisotope use is determined.
- c. All personnel who have unescorted access to Rad Level 3 or 4 labs must provide quarterly bioassay samples.
- d. It is required that all researchers working with >5 ALI’s of dry dispersible material, or > 100 ALI’s of dispersible material, provide bioassays samples on a quarterly basis. This requirement is included in the “UNLV Risk Assessment and Control Guideline for Unsealed Radioactive Material.”
- e. Urine analysis shall be required for all radiation workers entering areas controlled due to surface contamination in excess of the prescribed limits.
- f. Samples other than urine (fecal, for example) may also be required in certain instances. In vivo monitoring may also be required.
- g. Urine fecal samples shall be clearly labeled on the bottle with, at a minimum:
 - h. Name, and
 - i. The date(s) and time of sampling.
- j. NOTE: Be certain to attach the label to the sample bottle.
- k. The participant must fill out the UNLV Procedure for Bioassay Participants form.
- l. Radiation Safety will record all information on a Sample Chain of Custody Form to ensure control of the sample(s).

3.10 Emergency Bioassay Procedures

- a. In case of an incident where the potential of an intake of radioactive material exists, immediate evaluation and prompt personnel decontamination are required.
- b. During any personnel survey, if contamination is found on or around the face, nose, or mouth, a bioassay shall be required. Immediately take nasal swabs and face smears. Check the smears using a portable survey instrument and hold for further analysis. Begin decontamination procedures.
- c. Documentation of bioassay data is critical to ensuring that a complete and proper dose analysis can be made. The following information must be as accurate as possible.
 - i. Time and date of the contamination event,
 - ii. A discussion of the events leading to the emergency, the results of initial and current surveys of the personnel involved.
 - iii. The initial levels of contamination, radiation dose, chemical exposure, and any information concerning decontamination that may be available.
- d. For bioassay using urinalysis:
 - i. Collect the required volume of urine, recording the individual's name (or identification number), collection date, and collection time on the bottle.
 - ii. Collect one sample for each effective half-life duration for the radionuclides of interest, for three consecutive effective half-lives. This collection frequency determines radionuclide clearance rate.
 - iii. Send the urine samples to the analytical laboratory. Provide all information as necessary for the analysis.
- e. For contaminations involving transuranic compounds, a whole body count may facilitate adequate determination of the intake and may be desirable if such capability exists.
- f. Receive bioassay results from the laboratory.
- g. Include the analysis results, as provided by the laboratory, and the calculated committed dose equivalent and total effective dose equivalent in the worker's exposure file.
- h. **The Radiation Safety Officer shall review all documentation associated with the accidental exposure and develop a report for the individual's file to indicate internal and external dose equivalent. The RSO shall make all notifications as required by NAC 459 and inform the RSC chair.**

3.11 Bioassays for Exposure to Tritium

- a. It is required that bioassays be performed for individuals using tritium in accordance with the following schedule:

- b. If the amount of tritium used at any one time is between 10 mCi to 100 mCi, a urine bioassay sample shall be collected and analyzed within ten days following each procedure.
- c. If the amount of tritium used at any one time (i.e. within thirty consecutive days) is 100 mCi or greater, but less than 8.0 curies, a urine bioassay sample shall be collected and analyzed weekly.
- d. If the amount of tritium used at any one time is 8.0 curies or greater, the procedure must be carried out within a glove box, a urine bioassay sample shall be collected and analyzed daily.
- e. It is important to note that the 100 mCi quantity specified in the paragraphs above, applies to the H-3 gas or other tritiated materials with a similar biological half-life (i.e., approximately 12 days); if the biological half-life is longer (e.g., certain nucleotides), the 100 milliCuries "limit" may be reduced accordingly at the discretion of the RSO.
- f. In general, the term "used" means that personnel are exposed to the amounts described above by handling stock solutions, targets or by performing experimental procedures, etc.
- g. Bioassay shall be performed by the Radiation Safety Office or facility approved by the RSO using a calibrated liquid scintillation counter.

3.12 Bioassay for Exposure to Radioiodine

Any person who works with radioiodine in forms such that iodide ions or uncombined iodine might be present in quantities, which equal or exceed the values in the table given below, is required to have bioassays at intervals deemed appropriate by the RSO.

ACTIVITY ABOVE WHICH BIOASSAY FOR I-125 OR I-131 IS NECESSARY		
ACTIVITY HANDLED IN UNSEALED FORM		
Type of operation	Volatile or dispersible*	Bound to non-volatile agent
Processes in open room or bench, with possible escape of iodine from process vessels.	not allowed	1 mCi**
Processes with possible escape of iodine carried out within a fume hood of adequate design, face velocity and performance reliability	1 mCi**	10 mCi**
Processes carried out within glove boxes, ordinarily closed, but with possible release of iodine from process and occasional exposure to contaminated box and box leakage.	10 mCi**	100 mCi**

* Volatile radioiodine will only be handled in fume hoods or other systems that have been inspected and approved by the RSO.

** Quantities in this table are cumulative amounts handled during a three month period.

- a. Anyone working with levels within the above limits will have a baseline bioassay performed within two weeks prior to beginning work with radioactive iodine.
- b. When an investigator is terminating his work with radioiodine, a bioassay will be performed within two weeks of the last possible exposure to I-125 or I-131.
- c. Whenever an individual is found to have a thyroid burden in excess of 0.12 μCi of I-125 or 0.04 μCi of I-131, the Radiation Safety Office may take the following action:
 - i. Complete a thorough evaluation of all aspects of the iodination procedure.
 - ii. Restrict the worker from further exposure until the source of exposure is discovered and corrected.
 - iii. Repeat bioassay periodically to obtain an individual effective half-life and to determine estimated effective dose equivalent.
 - iv. Refer the individual to appropriate medical consultation for recommendations regarding therapeutic procedures that may be carried out to accelerate removal of radioiodine from the body.
 - v. Make reports of notifications as required by the State of Nevada Regulations for Radiation Control.

4.0 MEDICAL SURVEILLANCE POLICY

Personnel will be placed under medical surveillance when their potential exposure to ionizing radiation is such that somatic biological effects susceptible to detection by a medical evaluation could occur. Such appraisal will include an acute and chronic exposure evaluation and will consider many variables (duration, source, type of potential exposure, etc.). Personnel requiring medical surveillance will be referred to an examining physician by the RMS.

REFUSAL TO OBTAIN REQUIRED MEDICAL SURVEILLANCE WILL RESULT IN SUSPENSION OF AUTHORIZATION TO WORK WITH RADIOACTIVE MATERIALS.

5.0 EXPOSURE RECORDS AND EXAMINATIONS

1. It is the policy of the University of Nevada, Las Vegas to qualitatively and quantitatively determine internally deposited radioisotopes.

2. Examinations will be made of any student or employee who is suspected of or known to have ingested, inhaled, or absorbed radioisotopes. Urine radioanalysis, thyroid counting, and eye examinations may be required. Radiation workers shall be scheduled to appear at a prearranged time for the prescribed analysis. Failure to appear may result in denial of the privilege to use RAM.
3. Exposure records will consist of the following:
 - A. Any measurement made to detect internally deposited radioisotopes.
 - B. Information necessary to assess exposure.
 - C. Personnel dosimetry records.
4. Copies of exposure/medical examination records will be maintained in RMS and coordinated with personnel dosimetry data.

E. VISITOR DOSIMETRY

Visitors are not normally allowed in restricted areas. Prior arrangements should be made between the RSO and the AU if needs arise to have visitors in a restricted area. Visitors to areas where radioactive materials are used or stored may be provided with dosimetry at the discretion of the RSO. In addition, all visitors in these areas will be escorted by trained personnel from the lab to be visited or by a trained member of the radiation safety staff.

F. PROCEDURE WHEN EXPOSURE LIMITS ARE EXCEEDED

1. PROCEDURE WHEN ADMINISTRATIVE LIMITS ARE EXCEEDED

When UNLV Administrative Dose Control Limits (Section 1.III.A of this manual) are exceeded, the following procedures will be followed:

1. Within 5 working days from the notification that the administrative limits were exceeded, the Authorized User must file a report with the Radiation Safety Office describing any conditions or activities that may have led to the exposure.
2. The Radiation Safety Staff:
 - a. May change the dosimetry monitoring status to a more frequent interval if it is determined that the administrative limit was actually exceeded.
 - b. Review the individual's radiation work procedures and determine the likelihood of the cause of exposure.
 - c. Ensure that any unsafe practices are discontinued.
3. To prevent any delays in obtaining funds for the processing of unusually high bioassay results or hiring expert consultation to perform dose assessments, the

UNLV Senior Vice President of Finance and Business has committed to having these funds available. By his signing this Radiation Safety Manual, he has reaffirmed UNLV's commitment to having these resources with minimal delay.

2. REGULATORY LIMITS

The RSO or his/her designee must be notified IMMEDIATELY if any person is known to have, or suspected to have received a dose in excess of the Regulatory Limits. Such persons must receive proper and appropriate care in accordance with standard Health Physics and medical practices. The exact circumstances of such an event cannot be fully predicted, but as soon as possible (immediately is preferred), an investigation shall be undertaken to determine the circumstances of the incident and in order to determine the actual dose to the body and/or critical organ(s). Reports will be provided to regulatory authorities as required by regulations.

V. RECORDS KEEPING

In order to ensure compliance with NAC 459, certain records shall be maintained and made available to authorities. In accordance with this requirement and as part of good radiation safety practice, the Radiation Safety program requires that the following subsections be followed.

A. AUTHORIZED USER RESPONSIBILITIES

The authorized user shall:

1. Keep a current inventory of all radiation sources.
2. Keep a record of contamination and radiation surveys made in accordance with Procedure V (Radiation & Contamination Survey Procedure).

B. RADIATION SAFETY OFFICE RESPONSIBILITIES

The Radiation Safety Office shall maintain records of:

1. Current inventories of all radiation emitting materials and devices.
2. Radiation survey results and monitoring data.
3. All incidents (spills, releases, contamination problems) involving radiation sources, including investigation and resolution reports.

4. Leak test data on all sealed radiation sources.
5. Personnel monitoring results, and investigation and resolution reports in all cases of measurements exceeding Administrative ALARA Limits.
6. Instrument calibration results.
7. Waste disposal records.
8. License information.
9. Emergency equipment inventories and readiness inspections.
10. Radiation Safety Committee and Subcommittee meeting agendas and minutes.
11. Authorization applications, authorizations, and list of current Authorized Users
12. Deficiency citations and related documentation

VI. RESTRICTED AREA DESIGNATION AND FACILITY DESIGN CRITERIA

A: *RESTRICTED AREA DESIGNATION*

Restricted areas will be established for purposes of controlling movement of radiation sources and personnel. These areas will function to protect personnel and property from accidental contamination and unnecessary radiation exposure. Every individual working or visiting such areas must carefully observe signs and directions indicating the action to be taken in a specified area.

1. RESTRICTED AREA GENERAL RULES

- | | | |
|----------|-----------------------------------|---|
| 1 | Eating, drinking, smoking: | No eating, drinking, smoking or application of cosmetics is permitted in a radioisotope laboratory. |
| 2 | Wash Hands: | Wash hands after handling radioisotopes and before doing other work. |
| 3 | Pipetting: | Pipetting by mouth is prohibited. |

- 4 Protective Clothing:** Always use appropriate protective equipment when handling radioactive materials. Lab coats shall be worn in the laboratory and left in the laboratory. They shall not be used for other work, sent to another area, or released for cleaning until demonstrated to be free of contamination. Safety glasses should always be worn in chemical laboratories.
- 5 Confine the Activity:** Always work over lined trays or on benches covered with an absorbent material. Keep and transport radioisotopes in a secondary container.
- 6 Labeling:** Label radioactive material containers with your name, date, radionuclide and its quantity.
- 7 Before Leaving:** Clean up and monitor your work area and yourself at the end of each work period before leaving the laboratory. If any contamination was found reduce the level of contamination to below the maximum permissible level specified for the area.
- 8 Waste Disposal:** All radioactive wastes and contaminated materials shall be placed in the properly labeled radioactive waste containers. No radioactive material shall be placed in the non-radioactive regular waste. A radioactive waste log shall be on the radioactive waste container or near by.
- 9 Counting Room:** Take only prepared samples into the counting room. No externally contaminated material or equipment is permitted in rooms set up for low level radioactive material analysis.
- 10 Hoods:** Materials that could become airborne must be stored and used in an approved hood or glove box.
- 11 Security:** Secure all radioactive materials when laboratory is unoccupied or when authorized radiation workers are not present.
- 12 Personnel Monitoring:** Wear assigned personnel dosimeters whenever working with radioactive material.
- 13 Sewer Disposal:** No radioactive waste shall be placed into the sewer system by an AU or his/her associates or students.
- 14 Exposure:** No one shall cause any person unnecessary exposure to radiation.

FACILITY AREAS ARE DESIGNATED AS FOLLOWS:

1. UNRESTRICTED AREA

An area, access to which is neither limited nor controlled by the licensee. Radiation levels are such that dose from external sources does not exceed 0.002 rem in 1 hour and 0.1 rem in 1 year.

2. RESTRICTED AREA

Personnel monitoring may be required. Protective clothing requirements shall be clearly posted. Caution is to be exercised. Two examples are:

a. Radiation Area:

This area is defined in NAC 459.070 as follows: “Radiation area” means any area accessible to any person in which there exists radiation at a level that could result in a person receiving a dose equivalent in excess of 0.005 rem in 1 hour at 30 centimeters from the source of radiation or from any surface that the radiation penetrates.

b. High Radiation Area:

This area is defined in NAC 459.042 as follows: “High radiation area” means any area, accessible to persons, in which radiation exists at such levels that a person could receive a dose equivalent in excess of 0.1 rem in 1 hour at 30 cm from the source of radiation or from any surface that radiation penetrates.

4. CONTAMINATED AREA

Areas where work will continuously cause contamination of a work area may be designated as a contaminated area. The access to this area should be restricted to personnel who are aware of the contamination. Persons must not enter such an area without a specific reason to be there, authorization, and proper personal protection.

5. “AUTHORIZED PERSONNEL ONLY” AREA

“AUTHORIZED PERSONNEL ONLY” area is an area in which disruption or interference with the safe operation of a radiation source could occur by unauthorized entry.

NOTE: Persons must not enter into the above described areas unless authorized and equipped.

B: FACILITY DESIGN CRITERIA

1. GENERAL

1. Plans for shielding and shielding calculations shall be reviewed and approved by the RSO.
2. Whenever shielding is required it shall be designed to resist mechanical damage. (Shielding shall be constructed such that it will not cause a hazard due to collapse.)
3. Shielding shall be adequate (without cracks, gaps or voids) to reduce exposure to within the limits described in the following:
 - a. Dose rates in Unrestricted Areas shall not exceed 2 mrem per hour and 100 mrem per year.
 - b. Dose rates in any accessible, frequently occupied region within a Restricted Area shall not exceed 5 mrem/hr at 30 cm outside of the shielding.
 - c. Dose rates in any accessible but unoccupied area within a Controlled Area shall be below 100 mrem/hr at 1 ft from outside of the shielding.

NOTE: Radiation areas and High Radiation areas must be denoted in compliance with NAC 459.

2. INTERLOCKS, WARNING DEVICES, EMERGENCY SWITCHES

1. When conditions require installation of a radiation producing machine in a shielded enclosure, and the machine creates a High Radiation Area, all access doors shall be equipped with interlocks. These interlocks will shut the machine off if entry is attempted during machine operation.
2. In shielded enclosures, an Emergency Switch shall be placed within the enclosure allowing anyone to shut down the radiation machine. This switch shall be clearly labeled and shall not be capable of being reset from outside the enclosure.
3. When a safety interlock system has been tripped, it shall only be possible to resume operation of the machine by manually resetting controls at the position where the safety interlock has been tripped and, lastly, at the main control console.

3. POSTING

Each machine capable of producing ionizing radiation [X-Rays] shall be labeled as follows:

"CAUTION – THIS MACHINE] PRODUCES IONIZING RADIATION [X-RAYS] WHEN ENERGIZED" and other signs or labels as required. (Standard signs can be obtained from the Radiation Safety Office.) Additionally, analytical X-Ray machines shall have the following information prominently posted in the laboratory:

1. The name of the person responsible for the machine.
2. The name of each Authorized Operator.
3. Operating procedures, including general and specific safety instructions.
4. Emergency procedures giving the name and day and evening telephone numbers of the RSO.
5. Personnel monitoring requirements.

5. SPECIAL CONSIDERATIONS FOR CERTAIN RADIATION PRODUCING MACHINES OTHER THAN ACCELERATORS

a. *Electron Microscopes*

Normally these are low hazard devices. Operators need not wear personnel dosimeters. These devices must not be modified in any way that would reduce the effectiveness of the intrinsic shielding. These machines will be posted with appropriate signs if radiation survey results indicate any hazard.

b. *X-Ray Diffraction Machines*

The primary beams from these devices may be as high as 400,000 R/Minute. The chief hazard is one of hand exposure while setting up an experiment. Exposure to the primary beam will cause injury to the skin. The scattered beam also can exceed acceptable limits and may be as high as 150 R/Hr at 10 centimeters. Operators are required to be trained in the safe use of x-ray diffraction devices. Users of instruments that require hand-alignment or bypassing of safety interlocks shall wear both finger (or wrist) and whole body dosimetry. Users may be required to have survey instruments present and to make a radiation survey after a setup of the machine to ensure that shielding, collimators and beam stops are properly placed.

VII. EMERGENCY PROCEDURES

A. INTRODUCTION

In the case of an emergency situation, any medical emergency should take priority over radiological emergency.

The objectives for handling radiological emergencies are to

- Assist injured personnel,
- Minimize inhalation or ingestion of radioactive material into the human body,
- Prevent the spread of radioactive contamination,
- Remove the contamination as soon as possible, and
- Prevent recurrence of the accident.

When approaching radiological emergencies, it is recommended that these objectives be applied using standard laboratory safety precautions and a common sense approach because it is not possible to address all possible emergency scenarios.

All radiological incidents are to be reported to the Radiation Safety Office as soon as practical with the exception of easily managed minor contamination. All incidents must be documented. This documentation must include the final survey indicating that all contamination has been removed or reduced to the lowest practical level for that area.

B. PERSONNEL DECONTAMINATION

Contaminated areas of the body shall be identified using appropriate survey methods. The survey report shall be created after immediate emergency actions are completed and shall include at least the following information:

- The name of the contaminated person,
- The date of the event,
- The location of the event,
- The instrument model, serial number, and calibration due date, and
- A signed review note by the RSO.

Do not use any decontamination methods that may spread radioactive material, increase penetration into the body, or spread activity to any wounded area. Loose particles may be removed by gently applying adhesive side of tape to the particles attached to skin. Most contamination may be removed by running water over the contaminated area. Use soap or detergent if water by itself doesn't remove all the contaminants and by applying **gentle** scrubbing. Avoid harsh scrubbing that may increase skin penetration. If contamination

persists, stronger decontamination methods may be necessary after first consulting with the Radiation Safety Office.

C. LABORATORY SPILLS

Where the potential of spills of radioactive material exists, secondary containers or trays should be used. Containers should be covered whenever possible and only those amounts of radioactive material immediately necessary should be taken from the stock.

In the event of accidental spills of radioactive material, keep calm, use common sense, protect other people in the area, and do not spread the contamination. If high radiation levels are measured (0.5 R/hour or greater), or there is the possibility of airborne contamination from volatile radioactive material, evacuate the laboratory immediately; secure the laboratory to prevent entry; and notify the RSO. Unnecessary movement or touching shall be avoided. Use the following as guides; remember “SWIM”:

- S** **Stop** the spill. Take actions to prevent the further spread of radioactive contamination.
- W** **Warn** others. Notify persons in the area that a spill has occurred. Report the spill to the AU and/or RSO. Note contaminated and/or injured personnel. Call UNLV Police Services 911 for medical emergency. Treatment of life-threatening injuries takes priority over spill actions. Document all spill actions.
- I** **Isolate** the spill area. Use physical boundaries if possible. Verify contamination boundaries by scanning with the appropriate radiation detection instruments. Note that some isotopes (Tritium, H-3, for example) cannot be detected using portable instrumentation. A liquid scintillation counter must be used in this case.
- M** **Minimize** your exposure. Wear necessary protective clothing. Avoid contact with the skin. Utilize time distance and shielding. Avoid ingestion and inhalation of radiation.
- S** **Secure and Survey.** Take actions to secure the material and any unfiltered ventilation, if possible. Survey to ensure that contamination does not spread.

D. DECONTAMINATION OF MINOR SPILLS

Most incidents will involve small amounts (microCurie level) of radioactivity that are considered minor spills or contaminations. Commercially available cleaning supplies should be adequate. If necessary, it is recommended to use them only when other measures such as plain water do not work. The following steps are recommended;

1. Notify persons in the area that a spill has occurred.

2. Fresh new gloves should be worn to protect hands and avoid spread of contamination.
3. Prevent the spread of contamination by covering the spill with absorbent paper. (Paper should be dampened if solids are spilled.)
4. Mark off the contaminated area.
5. Allow no one to leave the area without first being monitored.
6. Clean up the spill, wearing disposable gloves and using absorbent paper.
7. Carefully fold the absorbent paper with the clean side out and place in a plastic bag for transfer to a radioactive waste container. Put contaminated gloves and any other contaminated disposable material in the bag.
8. Survey the area with an appropriate low-range radiation detector survey meter or other appropriate technique. Check the area around the spill for contamination. Also check hands, clothing, and shoes for contamination.
9. Secure all contaminated items in sealed containers to prevent spread of contamination.
10. Report the incident to the AU and RSO promptly.
11. Allow no one to return to work in the area unless approved by the AU and RSO.
12. Cooperate with the AU, RSO and/or the Radiation Safety Office (e.g., investigation of root cause, provision of requested bioassay samples).
13. Follow the instructions of the AU, RSO and/or the Radiation Safety Office (e.g., decontamination techniques, surveys, provision of bioassay samples, requested documentation).

E. MAJOR SPILLS

It is considered a major spill if greater than milliCurie quantities of radioactive materials are spilled, or if personnel are contaminated. It is not possible to address to all types of these accidents. But the following steps are general guide lines to deal with major accidents:

1. Shield the release of radioactivity or cut it off from the source if possible.
2. Clear the area. If appropriate, survey all persons not involved in the spill and vacate the room.
3. Prevent the spread of contamination by covering the spill with absorbent paper (paper should be dampened, if solids are spilled), but do not attempt to clean it up. To prevent the spread of contamination, limit the movement of all personnel who may be contaminated.
4. Minimize radiation exposure to personnel. Shield the source only if it can be done without further contamination or significant increase in radiation exposure.

5. If airborne radioactivity is possible, turn off hood, and close windows, shut off ventilation if possible.
6. Close the room and lock or otherwise secure the area to prevent entry. Post the room with a sign to warn anyone trying to enter that a spill of radioactive material has occurred.
7. Report the incident to the AU and RSO promptly.
8. Remain in the general area until the Radiation Safety Office personnel arrive.
9. Allow no one to return to work in the area unless approved by the RSO.
10. Cooperate with the RSO and/or the Radiation Safety Office (e.g., investigation of root cause, provision of requested bioassay samples).
11. Follow the instructions of the RSO and/or the Radiation Safety Office (e.g., decontamination techniques, surveys, provision of bioassay samples, requested documentation).

SECTION 3: APPENDIXES

APPENDIX A: RADIATION SAFETY OFFICE STAFF AND SERVICES

I. STAFF (NOMINAL)

- Radiation Safety Officer
- Alternate Radiation Safety Officer
- Radiation Safety Technician(s)

II. SERVICES

The following services shall be provided by the Radiation Safety Office for all Authorized Users at UNLV:

A. PERSONNEL MONITORING

Appropriate personnel monitoring devices will be assigned to each person who is likely to exceed 10% of annual external occupational exposure limits.

Personnel monitoring records will be maintained by the Radiation Safety Office. Exposures in excess of the Administrative Limit will be investigated.

B. RADIATION AND CONTAMINATION SURVEYS

Routine radiation and contamination surveys will be conducted by the Radiation Safety Office staff. The results will be recorded and reviewed. Special monitoring can be requested by contacting the Radiation Safety Office. Action will be taken immediately by the Radiation Safety Officer to eliminate conditions where personnel and/or property are in immediate danger. Routine surveys will be conducted every three months or less.

C. RADIATION INSTRUMENT CALIBRATION

The Radiation Safety Office is responsible for ensuring that all survey instruments in use are calibrated at intervals not to exceed 365 days. Requests for instrument calibrations should be made to the Radiation Safety Office. Sealed sources for calibration of counting equipment will be provided, on an "On Loan" basis, by the RSO to all Authorized Users.

D. WASTE PICK-UP AND DISPOSAL

All radioactive waste will be collected by the staff of the Radiation Safety Office. Waste will be stored according to its classification.

1. Dry waste shall be stored in closed containers lined with a heavy duty, transparent plastic liner approved by the RSO.
2. Liquid waste shall be stored in closed, leak tight containers approved by the RSO.
3. Liquid Scintillation Counter vials classified for waste disposal must be kept upright and stored so as to prevent leakage.
4. Animals and associated biological waste shall be frozen and placed in heavy plastic bags or containers. Such waste must never be stored in dry waste containers.
5. Waste that does not fall into the above categories must be stored in accordance with written recommendations from the Radiation Safety Office. The written recommendations shall be prominently posted at or near the storage location.
6. Non-radioactive waste must not be placed in radioactive waste storage containers.
7. When waste is placed in a storage container, the following information must be recorded on the container or log sheet:
 - a. The radionuclide, an estimate of the activity, and its chemical form.
 - b. The date.
 - c. The Authorized User's name.
8. The AU is responsible for keeping radioactive material inventory updated whenever transfer or disposal of such material occurs.

E. CONSULTANT SERVICES

The Radiation Safety Office will provide consultation on any matter relative to radiation safety. It will also provide advice and assistance on design of radiation experiments, radiation facilities, the purchase and use of radiation detection instruments, and on resolution of safety problems, such as spills.

F. TRANSPORTATION AND SHIPPING ASSISTANCE

Advice and assistance on transportation and shipping regulations will be provided for shipment of any radiation source. Radioactive materials must be checked by the Radiation Safety Office prior to shipment, unless the RSO approval has been obtained. Appropriate labels will be affixed to the package. Transportation or delivery of radioactive materials must be in compliance with provisions of DOT/IATA.

G. EMERGENCY ASSISTANCE

The Radiation Safety Office provides response to radiological emergencies. If a situation arises whereby radiation safety has been compromised, or a potential hazard exists, contact the Radiation Safety Office IMMEDIATELY. When a problem arises after hours, call the campus emergency Police Services telephone at 911. A copy of all emergency procedures and the list of emergency telephone numbers will be provided to all Authorized Users.

The Radiation Safety Office will promptly respond and determine gravity of emergency situation, provide guidance and assistance in radiation protection to personnel and/or emergency responders; and mitigate and eliminate consequences of emergency.

H. RADIATION SAFETY TRAINING

All persons must receive training prior to work with or around radiation or radioactive materials, and retraining is required annually. Such training shall be conducted by or coordinated with the RSO and shall follow the requirements of NAC 459.784 "Instructions to Employees". Training must be commensurate with the radiation sources(s) and the hazards associated with the procedures performed. Documentation of this training will be kept on file at the Radiation Safety Office.

The RSO may allow some Authorized Users to provide primary radiation safety training to students. Examples would be Health Physics and Radiography Program faculty, and there might be others. Training performed by such individuals must be documented as required by the RSO and copies of documentation, particularly the Acknowledgements of Training, must be provided to the Radiation Safety Office. Such documentation must also be kept on file in the Authorized User's laboratory or office.

APPENDIX B: ACRONYMS AND ABBREVIATIONS

ALARA	As Low As Reasonably Achievable
ALI	Annual Limit on Intake
ARSO	Alternate Radiation Safety Officer
AU	Authorized User
Bq	Becquerel
CEDE	Committed Effective Dose Equivalent
Ci	Curie
CPM	counts per minute
DAC	Derived Air Concentration
DAC-hour	Derived Air Concentration-hour
DOT	U.S. Department of Transportation
dpm	disintegrations per minute
EDE	Effective Dose Equivalent
EPA	U.S. Environmental Protection Agency
GFPC	gas-filled proportional counter
GFPD	gas-filled proportional detector
GM	Geiger-Mueller
Gy	gray
HPL	Health Physics Lab
IATA	International Air Transport Association
ICRP	International Commission on Radiological Protection
LSC	liquid scintillation counter
MDA	minimum detectable activity
MeV	mega (million) electron-volts
mrem	Millirem
NAC	Nevada Administrative Code
NRC	U.S. Nuclear Regulatory Commission
RCP	(Nevada) Radiation Control Program
NRS	Nevada Revised Statute
Q	Quality Factor

APPENDIX B: ACRONYMS AND ABBREVIATIONS (Cont.)

R	Roentgen
rad	radiation absorbed dose
RAM	radioactive material
rem	roentgen equivalent man or mammal
RMS	Risk Management and Safety
RPL	Radiation Protection Laboratory
RRA	Radiation Risk Assessment
RSC	Radiation Safety Committee
RSO	Radiation Safety Officer
RSP	Radiation Safety Program
RUA	Radiation Use Authorization
SNM	Special Nuclear Material
STP	standard temperature and pressure
Sv	Sievert
TEDE	Total Effective Dose Equivalent
TI	transport index
TLD	thermoluminescent dosimeters
UNLV	University of Nevada, Las Vegas
VPRED	Vice President of Research and Economic Development
WL	working level
WLM	working level month

APPENDIX C: DEFINITIONS

ABSORBED DOSE means the energy imparted by ionizing radiation per unit mass of irradiated material. The units of absorbed dose are the rad and the gray (Gy).

ACT means the Atomic Energy Act of 1954 (42 U.S.C. 20011 et seq.) as amended.

ACTIVITY is the rate of disintegration (transformation) or decay of radioactive material. The units of activity are the Curie (Ci) and the Becquerel (Bq).

ADMINISTRATIVE CONTROL LIMITS are 10% of the annual limits excluding the general public and declared pregnant worker limits. The administrative limits for the general public and declared pregnant worker are the same as the annual limits.

ADULT means an individual 18 or more years of age.

AIRBORNE RADIOACTIVE MATERIAL means radioactive material dispersed in the air in the form of dusts, fumes, particulates, mists, vapors, or gases.

AREA OF AIRBORNE RADIOACTIVITY means a room, enclosure, or area in which airborne radioactive materials, composed wholly or partly of licensed material, exist in concentrations-

- (1) In excess of the derived air concentrations (DACs) specified in Appendix B, NAC 459, or
- (2) To such a degree that an individual present in the area without respiratory protective equipment could exceed, during the hours an individual is present in a week, an intake of 0.6 percent of the annual limit on intake [ALI] or 12 DAC-hours.

ALARA (acronym for "as low as is reasonably achievable") means making every reasonable effort to maintain exposures to radiation as far below the dose limits in this part as is practical consistent with the purpose for which the licensed activity is undertaken, taking into account the state of technology, the economics of improvements in relation to state of technology, the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to utilization of nuclear energy and licensed materials in the public interest.

ANNUAL LIMIT ON INTAKE (ALI) means the derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year. ALI is the smaller value of intake of a given radionuclide in a year by the reference man that would result in a committed effective dose equivalent of 5 rems (0.05 Sv) or a committed dose equivalent of 50 rems (0.5 SV) to any individual organ or tissue. (ALI values for intake by ingestion and by inhalation of selected radionuclides are given in Table 1, Columns 1 and 2, of Appendix B, NAC 459.

APPLICATION FOR USE OF RADIONUCLIDES is an application that precedes the issuance of a Radiation Use Authorization (RUA). Separate applications are required for non-human research use and non-human classroom use (a Classroom Use Authorization).

BACKGROUND RADIATION means radiation from cosmic sources; naturally occurring radioactive materials, including radon (except as a decay product of source or special nuclear material) and global fallout as it exists in the environment from the testing of nuclear explosive devices. "Background radiation" does not include radiation from source, byproduct, or special nuclear materials regulated by the Commission.

BECQUEREL (Bq) is a unit of radioactivity equal to one disintegration per second.

BIOASSAY (radiobioassay) means the determination of radionuclide, activity or activity concentrations, and, in some cases, the locations of radioactive material in the human body, whether by direct measurement (in vivo counting) or by analysis and evaluation of materials excreted or removed from the human body.

BYPRODUCT MATERIAL means: (1) Any radioactive material (except special nuclear material) yielded in, or made radioactive by, exposure to the radiation incident to the process of producing or utilizing special nuclear material and (2) The tailing or wastes produced by the extraction or concentration of uranium or thorium from ore processed primarily for its source material content, including discrete surface wastes resulting from uranium solution extraction processes. Underground ore bodies depleted by these solution extraction operations do not constitute "byproduct material" within this definition.

CLASS (or Lung class or Inhalation class) means a classification scheme for inhaled material according to its rate of clearance from the pulmonary region of the lung. Materials are classified as D, W, or Y, which applies to a range of clearance half-times: for Class D (Days) of less than 10 days, for Class W (Weeks) from 10 to 100 days, and for Class Y (Years) of greater than 100 days.

COLLECTIVE DOSE is the sum of the individual doses received in a given period of time by a specified population from exposure to a specified source of radiation.

COMMISSION means the U.S. Nuclear Regulatory Commission or its duly authorized representatives.

COMMITTED DOSE EQUIVALENT ($H_{T,50}$) means the dose equivalent to organs or tissues of reference (T) that will be received from an intake of radioactive material by an individual during the 50-year period following the intake.

COMMITTED EFFECTIVE DOSE EQUIVALENT ($H_{E,50}$) is the sum of the products of the weighting factors applicable to each of the body organs or tissues that are irradiated and committed dose equivalent to these organs or tissues ($H_{E,50} = \sum W_T H_{T,50}$).

CONTROLLED AREA means an area outside of a restricted area, but inside the site boundary, access to which can be limited by the licensee for any reason.

CURIE is the basic unit of radioactivity, abbreviated Ci. A sample has an activity of one curie if it decays at a rate of $3.7E10$ disintegrations per second (dps). Subunits of the Curie are:

$$\begin{aligned}\text{milliCurie (mCi)} &= 3.7E7 \text{ dps} \\ \text{microCurie (uCi)} &= 3.7E4 \text{ dps} \\ \text{picoCurie (pCi)} &= 3.7E-2 \text{ dps}\end{aligned}$$

The international unit for activity is the Becquerel (Bq). One disintegration per second is equal to one Becquerel.

DECLARED PREGNANT WOMAN means a woman who has voluntarily informed her employer, in writing, of her pregnancy and the estimated date of conception.

DEEP-DOSE EQUIVALENT (H_a), which applies to external whole-body exposure, is the dose equivalent at a tissue depth of 1 cm (1000 mg/cm^2).

DERIVED AIR CONCENTRATION (DAC) means the concentration of a given radionuclide in air which, if breathed by the reference man for a working year of 2,000 hours under conditions of light work (inhalation rate 1.2 cubic meters of air per hour), results in an intake of one ALI. DAC values are given in Table 1, Column 3, of Appendix B to NAC 459.

DERIVED AIR CONCENTRATION-HOUR (DAC-hour) is the product of the concentration of radioactive material in air (expressed as a fraction or multiple of the derived air concentration for each radionuclide) and the time of exposure to that radionuclide, in hours. A licensee may take 2,000 DAC-hours to represent one ALI, equivalent to a committed effective dose equivalent of 5 rems (0.05 Sv).

DOSE OR RADIATION DOSE is a generic term that means absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, or total effective dose equivalent, as defined in other paragraphs of this section.

DOSE EQUIVALENT (H_T) means the product of the absorbed dose in tissue, quality factor, and all other necessary modifying factors at the location of interest. The units of dose equivalent are the rem and sievert (Sv).

DOSIMETRY PROCESSOR means an individual or an organization that processes and evaluates individual monitoring equipment in order to determine the radiation dose delivered to the equipment.

EFFECTIVE DOSE EQUIVALENT (H_E) is the sum of the products of the dose equivalent to the organ or tissue (H_T) and the weighing factors (W_T) applicable to each of the body organs or tissues that are irradiated ($H_E = \sum W_T H_T$).

EMBRYO/FETUS means the developing human organism from conception until the time of birth.

ENTRANCE OR ACCESS POINT means any location through which an individual could gain access to radiation areas or to radioactive materials. This includes entry or exit portals of sufficient size to permit human entry, irrespective of their intended use.

EXPOSURE means being exposed to ionizing radiation.

EXTERNAL DOSE means that portion of the dose equivalent received from radiation sources outside the body.

EXTREMITY means hand, elbow, arm below the elbow, foot, knee, or leg below the knee.

EYE DOSE EQUIVALENT applies to the external exposure of the lens of the eye and is taken as the dose equivalent at a tissue depth of 0.3 centimeter (300 mg/cm²).

GENERALLY APPLICABLE ENVIRONMENTAL RADIATION STANDARDS means standards issued by the U.S. Environmental Protection Agency (EPA) under the authority of the Atomic Energy Act of 1954, as amended, which impose limits on radiation exposures or levels, or concentrations or quantities of radioactive material, in the general environment outside the boundaries of locations under the control of persons possessing or using radioactive material.

GOVERNMENT AGENCY means any executive department, commission, independent establishment, corporation wholly or partly owned by the United States of America, which is an instrumentality of the United States, or any board, bureau, division, service, office, officer, authority, administration, or other establishment in the executive branch of the Government.

GRAY (Gy) is the SI unit of absorbed dose. One gray is equal to an absorbed dose of 1 Joule/kilogram (100 rads).

HIGH RADIATION AREA means an area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.1 rem (1 mSv) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

INDIVIDUAL means any human being.

INDIVIDUAL MONITORING means (1) the assessment of dose equivalent by the use of devices designed to be worn by an individual: (2) The assessment of committed effective dose equivalent by bioassay (see *Bioassay*) or by determination of the time-weighted air concentrations to which an individual has been exposed, i.e. DAC-hours: or (3) The assessment of dose equivalent by the use of survey data.

INDIVIDUAL MONITORING DEVICES (INDIVIDUAL MONITORING EQUIPMENT) means devices designed to be worn by a single individual for the assessment of dose equivalent such as film badges, thermoluminescent dosimeters (TLDs), pocket ionization chambers, and personal ("lapel") air sampling devices.

INTERNAL DOSE means that portion of the dose equivalent received from radioactive material taken into the body.

IONIZING RADIATION: Any electromagnetic or particulate radiation capable of producing ions directly or indirectly in its passage through matter. In general, it will refer to gamma rays and x-rays, alpha and beta particles, neutrons, protons, high speed electrons, and other nuclear particles; not sound or radio waves, or visible, infrared or ultra-violet light.

LICENSE means a license issued by the Division in accordance with the provisions of NAC 459.010 to 459.950, inclusive, and Chapter 459 of NRS.

LICENSED RADIOACTIVE MATERIAL means any radioactive material that is possessed under a specific or general license issued by the State of Nevada or the United States Nuclear Regulatory Commission.

LICENSEE means the holder of a license.

LIMITS (dose limits) means the permissible upper bounds of radiation doses.

LOST OR MISSING LICENSED MATERIAL means licensed material whose location is unknown. It includes material that has been shipped but has not reached its destination and whose location cannot be readily traced in the transportation system.

MEMBER OF THE PUBLIC means an individual in an uncontrolled or unrestricted area. However, an individual is not a member of the public during any period in which the individual receives an occupational dose.

MINOR means an individual less than 18 years of age.

MONITORING (radiation monitoring, radiation protection monitoring) means the measurement of radiation levels, concentrations, surface area concentrations or quantities of radioactive material, and the use of the results of these measurements to evaluate potential exposures and doses.

NAC 459: Refers to the Nevada Administrative Code 459.010-950, inclusive, which contains regulations and requirements governing the University license.

NONSTOCHASTIC EFFECT means a health effect, the severity of which varies with the dose and for which a threshold is believed to exist. Radiation-induced cataract formation is an example of a nonstochastic effect (also called a deterministic effect).

NRC means the U.S. Nuclear Regulatory Commission or its duly authorized representative.

OCCUPATIONAL DOSE means the dose received by an individual in a restricted area or in the course of employment in which the individual's assigned duties involve exposure to radiation and to radioactive material from licensed and unlicensed sources of radiation, whether in the possession of the licensee or other person. Occupational dose does not include dose received from background radiation, as a patient from medical practices, from voluntary participation in medical research programs, or as a member of the general public.

PERSON has the meaning ascribed to it in subsection 5 of NRS 459.010

PERSONNEL DOSIMETRY are devices that measure the cumulative dose of radiation to an individual.

PLANNED SPECIAL EXPOSURE means an infrequent exposure to radiation, separate from and in addition to the annual dose limits.

PUBLIC DOSE means the dose received by a member of the public from exposure to radiation and to radioactive material released by a licensee, or to another source of radiation either within a licensee's controlled area or in unrestricted areas. It does not include occupational dose or doses received from background radiation, as a patient from medical practices, or from voluntary participation in medical research programs.

QUALITY FACTOR (Q) means the applicable modifying factor that is specified in NAC 459.3235. The quality factor is used to convert absorbed dose to dose equivalent.

QUARTER means a period of time equal to one-fourth of the year observed by the licensee (approximately 13 consecutive weeks), providing that the beginning of the first quarter in a year coincides with the starting date of the year and that no day is omitted or duplicated in consecutive quarters.

RAD is the special unit of absorbed dose. One rad is equal to an absorbed dose of 100 ergs/gram or 0.01 joule/kilogram (0.01 gray).

RADIATION (ionizing radiation) means alpha particles, beta particles, gamma rays, X-rays, neutrons, high-speed electrons, high-speed protons, and other particles capable of

producing ions. Radiation, as used in this part, does not include non-ionizing radiation, such as radio- or microwaves, or visible, infrared, or ultraviolet light.

RADIATION AREA means an area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.005 rem (0.05 mSv) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

RADIATION PRODUCING MACHINE: Any device capable of producing ionizing radiation when the associated control devices are operated, but excluding devices that produce radiation only by the use of radioactive materials.

RADIATION SOURCE: A radiation source is any radionuclide, x-ray machine, accelerator, or other device capable of emitting ionizing radiation and is subject to the provisions of this Manual. Ionizing radiation is any particulate or electromagnetic radiation capable of producing biological damage.

RADIATION USE AUTHORIZATION (RUA): An authorization issued by the Radiation Safety Committee to conduct specific research or education/training using specific radioisotopes.

RADIOACTIVE CONTAMINATION: Deposition of radioactive material where it is not desired.

RADIOACTIVE MATERIALS: Any material, solid, liquid, or gas that emits ionizing radiation spontaneously, including radioactive waste.

REFERENCE MAN means a hypothetical aggregation of human physical and physiological characteristics arrived at by international consensus. These characteristics may be used by researchers and public health workers to standardize results of experiments and to relate biological insult to a common base. ICRP publications 23 and 89 describe the characteristics of reference humans.

REM is the special unit of any of the quantities expressed as dose equivalent. The dose equivalent in rems is equal to the absorbed dose in rads multiplied by the quality factor (1 rem = 0.01 sievert).

RESPIRATORY PROTECTIVE DEVICE means an apparatus, such as a respirator, used to reduce the individual's intake of airborne radioactive materials.

RESTRICTED AREA means an area, access to which is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials. Restricted area does not include areas used as residential quarters, but separate rooms in a residential building may be set apart as a restricted area.

ROENTGEN is the quantity of X or gamma radiation (NOT alpha or beta radiation) that results in 1 electrostatic unit (esu) of ionization per 1 cubic centimeter (cc) of dry air, at Standard Temperature and Pressure (STP) at the point of measurement. One esu represents $2E9$ ion pairs, or $2.58E-4$ coulombs/kg air. This amount of radiation imparts an amount of energy equivalent to $5.4E7$ MeV per gram of air, or 0.87 RAD to air. A Roentgen of X-radiation in the energy range of 0.1 to 3.0 MeV also produces 0.9 RAD in tissue. Thus, for most purposes, values of exposures in Roentgens can be considered essentially equal to absorbed doses in RADS to tissue irradiated at the same point, or to dose equivalents in REM.

SANITARY SEWERAGE means a system of public sewers for carrying off waste water and refuse, but excluding sewage treatment facilities, septic tanks, and leach fields owned or operated by the licensee.

SHALLOW-DOSE EQUIVALENT (H_s), which applies to the external exposure of the skin or an extremity, is taken as the dose equivalent at a tissue depth of 0.007 centimeter (7 mg/cm^2) averaged over an area of 1 square centimeter.

SIEVERT is the SI unit of any of the quantities expressed as dose equivalent. The dose equivalent in Sieverts is equal to the absorbed dose in grays multiplied by the quality factor ($1 \text{ Sv}=100 \text{ rems}$).

SITE BOUNDARY means that line beyond which the land or property is not owned, leased, or otherwise controlled by the licensee.

SOURCE MATERIAL means - (1) Uranium or thorium or any combination of uranium and thorium in any physical or chemical form; or (2) Ores that contain, by weight, one-twentieth of 1 percent (0.05 percent), or more, of uranium, thorium, or any combination of uranium and thorium. Source material does not include special nuclear material.

SPECIAL NUCLEAR MATERIAL (SNM) is defined by Title I of the Atomic Energy Act of 1954 as plutonium, uranium-233, or uranium enriched in the isotopes uranium-233 or uranium-235. The definition includes any other material that the Commission determines to be special nuclear material, but does not include source material. The NRC has not declared any other material as SNM.

STOCHASTIC EFFECTS means health effects that occur randomly and for which the probability of the effect occurring, rather than its severity, is assumed to be a linear function of dose without threshold. Hereditary effects and cancer incidence are examples of stochastic effects.

SURVEY means an evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal, or presence of radioactive material or other sources of radiation. When appropriate, such an evaluation includes a physical survey of the location of radioactive material and measurements or calculations of levels of radiation, or concentrations or quantities of radioactive material present.

TRANSPORT INDEX (TI): The dimensionless number (rounded up to the next tenth) placed on the label of a package to designate the degree of control to be exercised by the carrier during transportation. The transport index is equal to the maximum radiation level in millirem per hour at one meter from the surface of the package.

TOTAL EFFECTIVE DOSE EQUIVALENT (TEDE) means the sum of the deep dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).

UNRESTRICTED AREA means an area, access to which is neither limited nor controlled by the licensee.

URANIUM FUEL CYCLE means the operations of milling of uranium ore, chemical conversion of uranium, isotopic enrichment of uranium, fabrication of uranium fuel, generation of electricity by a light-water-cooled nuclear power plant using uranium fuel, and reprocessing of spent uranium fuel to the extent that these activities directly support the production of electrical power for public use. Uranium fuel cycle does not include mining operations, operations at waste disposal sites, transportation of radioactive material in support of these operations, and the reuse of recovered non-uranium special nuclear and byproduct materials from the cycle.

VERY HIGH RADIATION AREA means an area, accessible to individuals, in which radiation levels could result in an individual receiving an absorbed dose in excess of 100 rads (1 gray) in 1 hour at 1 meter from a radiation source or from any surface that the radiation penetrates. (NOTE: At very high doses received at high dose rates, units of absorbed dose (e.g., rads and grays) are appropriate, rather than units of dose equivalent (e.g., rems and sieverts)).

WEEK means 7 consecutive days starting on Sunday.

WEIGHTING FACTOR w_T , for an organ or tissue (T) is the proportion of the risk of stochastic effects resulting from irradiation of that organ or tissue to the total risk of stochastic effects when the whole body is irradiated uniformly. For calculating the effective dose equivalent, the values of w_T are:

ORGAN DOSE WEIGHTING FACTORS	
<i>Organ or tissue</i>	w_T
Gonads	0.25
Breast	0.15
Redbone marrow	0.12
Lung	0.12
Thyroid	0.03
Bone surfaces	0.03
Remainder	0.30 ¹
Whole body	1.00 ²

¹0.30 results from 0.06 for each of 5 "remainder" organs (excluding the skin and the lens of the eye) that receive the highest doses.

² For the purpose of Weighting the external whole body dose (for adding it to the internal dose), a single weighting factor $w_T=1.0$, has been specified. The use of other weighting factors for external exposure will be approved on a case-by-case basis until such time as specific guidance is issued.

WHOLE BODY means, for purposes of external exposure, head, trunk (including male gonads), arms above the elbow, or legs above the knee.

WORKING LEVEL (WL) is any combination of short-lived radon daughters (for radon-222: polonium-218, lead-214, bismuth-214, and polonium-214; and for radon-220: polonium-216, lead-212, bismuth-212, and polonium-212) in 1 liter of air that will result in the ultimate emission of 1.3×10^5 MeV of potential alpha particle energy.

WORKING LEVEL MONTH (WLM) means an exposure to 1 working level for 170 hours (2,000 working hours per year/12 months per year = approximately 170 hours per month).

YEAR means the period of time beginning in January used to determine compliance with the provisions of this part. The licensee may change the starting date of the year used to determine compliance by the licensee provided that the change is made at the beginning of the year and that no day is omitted or duplicated in consecutive years.

APPENDIX D: GENERAL RADIATION LABORATORY RULES

These rules are designed to limit unnecessary radiation exposures and contamination of facilities and equipment, and to minimize the consequences of a radiation accident if it should occur. Copies of these rules shall be prominently displayed in all designated laboratories.

GENERAL PROCEDURES:

1. Eating, drinking, smoking, or applying cosmetics is not permitted in any area where radioactive material is used or stored.
2. Wash hands after handling any radioactive material and going about other work or leaving the area.
3. Pipetting by mouth is prohibited.
4. Always use rubber or plastic gloves when handling radioactive material. Lab coats shall be worn in the laboratory and left in the laboratory. Do not wear gloves or lab coats out of the laboratory unless actually transporting radioactive material.
5. Safety glasses shall be worn in areas where liquid radioactive material is present and kept in the restricted area.
6. Always work over trays or work surfaces lined with absorbent material. Keep and transport radioactive materials doubly contained.
7. Immediately control any spill with absorbent paper and/or a container and notify the Radiation Safety Office.
8. Label containers of radioactive material with your name, date, radionuclide and quantity of radionuclide.
9. Before leaving the laboratory, clean up and monitor your work area and yourself, remove any contamination found, and re-monitor the area to ensure successful decontamination.
10. Liquid radioactive waste must be put in plastic Radioactive Waste bottles. The radionuclide, quantity, and date of disposal must be recorded on the waste container.
11. Solid radioactive waste must be placed in plastic or plastic-lined containers. The radionuclide, quantity, chemical properties, and date of disposal must be recorded on the waste container log sheet.
12. Take only prepared samples into the counting room. No potentially contaminated material or apparatus is permitted in the counting room.
13. Hoods must be used for all unsealed radioactive material unless specified otherwise in the individual's Radiation Use Application.
14. Lock up all radioactive materials when the laboratory is unoccupied or when authorized radiation workers are not present even if for only a few minutes. We all share the responsibility of security of radioactive materials no matter how small the quantity.

APPENDIX E: FORMS

NOTE: *Forms subject to change. Consult the Radiation Safety Office website, <https://www.unlv.edu/rms/radiological>, for current versions.*

- RSO-1 Receipt of Radioactive Materials
- RSO-2 Radioisotope Use Log
- RSO-3 Waste Disposal Inventory
- RSO-4 Radioactive Material Transfer Form
- RSO-5 Inspection List
- RSO-8 Acknowledgement of Training
- RSO-8A Declaration of Pregnancy
- RSO-9 Request for Personal Dosimetry
- RSO-9B Lost Badge Report
- RSO-10 Counting Instrument Efficiencies and MDA
- RSO-11 Leak Test Certificate
- RSO-13 Survey Meter Calibration Certificate
- RSO-14 Source Disposal Container Contents
- RSO-18 Application for Use of Radioactive Material
- RSO-19 Fume Hood Check Posting Form
- RSO-20 Room Check Form
- RSO-23 Procedure for Bioassay Participants – Urine
- RSO-23A Procedure for Bioassay Participants - Fecal
- NRC-1 Notice to Employees

RADIATION SAFETY OFFICE
RECEIPT OF RADIOACTIVE MATERIAL PROCEDURE

RSO Policy: All radioactive materials must be received and inventoried by the Radiation Safety Office. Monitoring must be performed as soon as practicable after receipt, but no longer than three hours after the package is received if during normal working hours or no later than 3 hours after the beginning of the next working day if received after normal working hours.

- 1. NAME OF AUTHORIZED USER 2. DEPARTMENT
3. P.O. NUMBER 4. DATE AND TIME RECEIVED
5. MANUFACTURER & LOT NUMBER 6. RADIONUCLIDE(S)
7. QUANTITY (mCi) 8. ASSAY DATE 9. CHEMICAL FOR

10. DOSE RATE SURVEY RESULTS:
Circle Correct Units: (mR/hr) (mRem/hr) (µRem/hr) (µR/hr)

Table with 3 columns: Dose Rate Meter Manufacturer, Model #, Serial #

- 11. Background Dose Rate Response: Check Source Response:
12. PACKAGE BEFORE OPENING, AT 1 METER SURFACE
13. PACKAGE MATERIALS AFTER OPENING, SURFACE
14. CONTAINER REMOVED FROM PACKAGING, SURFACE

Evaluation of area with portable contamination survey meter: Satisfactory

Table with 3 columns: Portable Contamination Meter Manufacturer, Model #, Serial #

15. CONTAMINATION SURVEY RESULTS: (cpm) (dpm)

Table with 4 columns: Smear Counter Manufacturer, Type (LSC, GPC), Model #, Serial #

Table with 4 columns: Location, Smear Number, Alpha Activity, Beta Activity

Signature: _____ Date: _____
Smear Analysis Printout Attached Yes No

Initials: _____, I acknowledge that I am responsible for the security of this RAM package and it must be properly secured within an approved RAM storage/use location immediately.

Accepted by: _____ Date: _____ Location: _____

RADIATION SAFETY OFFICE

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(702) 895-4226

RADIOACTIVE MATERIAL INTERNAL TRANSFER

(For Transfer of Materials from One Authorized User to Another within UNLV)

User Transferring Material

(PRINT NAME)

(SIGNATURE)

(DATE)

User Receiving Material

(PRINT NAME)

(SIGNATURE)

(DATE)

Material to be transferred:

Table with 4 columns: Nuclide, Activity (milliCuries), RAM Number. Rows 1-6.

Material must be entered into inventory control files - Signature below indicates that this has been completed.

UNLV RSO Approval

(PRINT NAME)

(SIGNATURE)

(DATE)

PRE-TRANSFER CONTAINER SURVEY

Form with fields: Performed by, Date, Survey Instrument, Make, Model, S/N, Dose Equivalent Rate at Surface, Contamination Survey Result, Transferred by, Date.

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Received by:	Date:
--------------	-------

Continuation Sheet

**RADIOACTIVE MATERIALS TRANSFER
(CONTINUATION SHEET)**

	Nuclide	Activity (milliCuries)	RAM Number
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			
15.			
16.			
17.			
18.			
19.			
20.			
21.			
22.			
23.			
24.			
25.			
26.			
27.			
28.			
29.			
30.			

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RADIOACTIVE MATERIALS INSPECTION REPORT

Inspector: _____ Authorized User: _____
Date: _____ Radionuclide(s): _____
Building: _____ Rooms: _____

S = Satisfactory I = Improvement Needed V = Violation* C = Comment NA = Not Applicable
*(response required)

Postings, Notifications, Information:

- 1. Radiation / Radioactive Materials warning labels posted on outside of doors and storage areas (RMS).
2. Radiation Safety Manual present and in clear view
3. Notice to Employees, RSO phone #, label posted giving NAC 459 location (RMS).
4. NRC-1, posted (RMS).
5. No eating, drinking, or smoking labels posted (RMS)
6. Emergency procedures and 24/7 contact information

Internal Dose Control

- 7. No evidence of food or drink
8. Potentially contaminated areas segregated and labeled
9. Routine and "After Use" contamination surveys performed
10. Survey meter(s): adequate # ___ within calibration period ___ operable or labeled ___
11. Sample counting equipment: type (LSC/GPC/SC) within calibration ___
12. Secondary containment for liquid RAM
13. Fume hood - no excessive clutter, airfoil & exhaust slots unobstructed, glass clear, sash and light working
14. Appropriate personal protective equipments available and worn

External Dose Control

- 15. Dose rate meter(s): # ___ within calibration period ___ operable or labeled ___
16. Adequate shielding materials available and in use

Inventory and Waste

- 17. Radioactive materials use log, RSO Form #2, entries dated and signed by user
18. Waste containers labeled and closed / Waste log entries kept
19. No evidence of sink or drain disposal

Security

- 20. Door(s) secured against unauthorized entry; radioactive sources secured
21. Storage location(s) locked

Administrative

- 22. Protocol available, signed and appropriate for work being performed.
23. AU providing appropriate physical oversight for Rad Safety Level
24. Rad and Engineering controls being used per protocol requirements

Comments:

RADIATION SAFETY OFFICE

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FORM LETTER FOR DECLARING PREGNANCY

This form letter is provided for your convenience. To make your declaration of pregnancy, you may fill in the blanks in this form letter and give it to your Radiological Safety Officer (RSO) or you may write your own letter.

DECLARATION OF PREGNANCY

To: _____, UNLV Radiation Safety Officer

I am declaring that I am pregnant. I believe I became pregnant in:
(only the month and year need to be provided).

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

If I find out that I am not pregnant, or if my pregnancy is terminated, I will promptly inform you in writing that my pregnancy has ended. (This promise to inform your employer in writing when your pregnancy has ended is optional. The sentence may be crossed out if you wish.)

(Your signature)

(Your name printed)

(Date)

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Acknowledgement of Training Received

This is to state that I understand the instruction provided by the Radiation Protection Program and associated regulations, and that any questions that I have had about these matters have been answered to my satisfaction. Further, I acknowledge and agree that:

1. I have been informed of the risks associated with exposure to radiation, including Possible Health Risks to Children of Women Who Are Exposed to Radiation During Pregnancy (NRC Regulatory Guide 8.13), and of the procedures used to minimize that exposure.
2. I will strictly comply with the rules and procedures of my facility pertaining to the protection of personnel from exposure to radiation, and I will maintain my exposures ALARA. I will comply with all provisions of Nevada State regulations.
3. If I am issued a dosimeter (badge), I will wear the badge at the neck, facing outward, (unless otherwise directed by the RSO or his assistant) on the outside of my lead apron or outer clothing whenever entering an area restricted for radiation protection on assignment.
4. I will keep the badge in the specific storage location when I am not wearing it, and I will not remove the badge from the work location unless directed to do so by the RSO or his assistant. I will ensure that the badge is in the specific storage location for exchange or pickup on the 15th of the odd-numbered months of the year, or as directed by my supervisor.
5. **If I lose or misplace the badge, I will immediately notify my supervisor and obtain a Lost Badge Report, which I will complete and return to my supervisor as soon as possible. I understand that failure to do this may result loss of work privilege or a hold being placed on my records by the Registrar’s Office.**
6. I shall report in writing any concurrent employment where personal radiation dose is monitored, and I authorize the release of my dosimetry information to the UNLV RSO. I shall not wear the UNLV-issued badge while working for another employer involving radiation exposure.
6. I understand that it is voluntary but strongly recommended that female personnel report pregnancy to the RSO in writing, including an estimate of the date of conception. This information is kept confidential by the office, and mutually agreeable actions may be taken to monitor radiation exposure to the embryo/fetus and assure that assignments will not result in exposures exceeding the provisions of NAC 459.333. I further understand that the declaration may be rescinded at any time.

PRINT NAME

DATE

SIGNATURE

RADIATION SAFETY OFFICE

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Request for Personnel Dosimetry

Full Name: _____
Last First Middle

UNLV ID #: _____ DOB: _____ Sex: _____

Social Security Number: _____ Only provide SSN for previous exposure

Mailing Address: _____

Academic Program/Department: _____ Supervisor: _____

Position in Program/Department: _____ Sources/RPD working with: _____

For RSO Office Use Only			
Added to Landauer date:	Group No:	Training date:	
Type of Badge: Whole Body	Collar	Fetal	Ring
If Spare issued, No:	Badge No:	Badge Series:	

THIS YEAR, have you worn a radiation detection badge at a location other than UNLV? (Circle one-) **Yes No**

If **YES**, provide your social security number with personal information above and give the complete name and address of that employer and the dates worked below:

Facility Name: _____

Address: _____

City: _____ State/Country: _____ Zip: _____

Dates employed: From _____ to _____

I hereby authorize my previous employer/academic institution to release my radiation exposure records to the University of Nevada, Las Vegas. (Radiation Safety Office, UNLV, 4505 Maryland Parkway, Las Vegas, NV 89154-1042).

Signature: _____ Date of Request: _____

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LOST BADGE REPORT

NAME (Print): UNLV ID Number:

I have been notified that the radiation dosimeter number issued to me on (Date) has not been returned or was not read for other reasons. I am submitting the following information covering the period of time relevant to the missing dosimetry:

Work Location While Wearing Badge:

(Name of all clinics, hospitals, universities, etc)

Start Date: End Date:
(Should correspond to date badge was issued) (Should correspond to date badge was lost)

Type of work done during this time period:

(Fluoro, C-arm, Still Radiography, I-125 work, etc.)

Total Hours Worked During Month(s):

(Should correspond to total hours badge worn)

Name of Person(s) Who I worked with during this time period:

I understand that the Radiological Safety Office will estimate the dose accumulated during the period in question from dosimetry records of those who accompanied me into the work area, other comparable dosimetry records and my own exposure history.

Signature Date

User Name Signature Date

Do Not Write Below This Line

Lost Dosimeter Number Lost Dosimeter Type Group Department

Date Dosimeter Issued Dose Estimate (millirem) (Deep:), (Eye:), (Shallow:)

Signature Date

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COUNTING INSTRUMENT EFFICIENCIES AND MDA

User _____ Instrument Type _____ Date _____

Instrument Make _____ Model _____ S/N _____

Building _____ Room _____

EFFICIENCIES
EFF = (CPM/DPM)*100%

Standard Nuclide _____

Lot Number _____

CPM _____

DPM _____

EFF _____% _____% _____%

Background _____

MDA (dpm) _____

MINIMUM DETECTABLE ACTIVITY: $MDA = (4.65 S + 3) / KT$

Where: $K = EFF$

$S = \sqrt{N}$

N = Total Background Count

T = Sample counting time in minutes

(MDA will be in dpm)

For MDA in microcuries: multiply by $1 = 1 \text{ uCi. } / 2.22 * 10^{**6} \text{ dpm}$

Calculations:

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LEAK TEST CERTIFICATE

Source Location

Building _____ Room _____ Dept. _____

Source manufactured by _____

Source Model No. _____

Serial No. _____ UNLV Number: _____

Nuclide _____ Activity (mCi.) _____ As of Date: _____

Date of Wipe _____ Count Date _____ Result (max uCi.) _____

Wipe test taken by _____

Authorized User _____

SAMPLE ANALYSIS DATA

Counting Instrument _____ Model _____ S/N _____

Counting Time _____ Background _____ MDA _____

Efficiency (%) _____ Standard Nuclide _____

Maximum Sample Count _____ Maximum Sample dpm _____

0.005 uCi. or greater is considered a leaking source

NDA means "No Detectable Activity" above the MDA specified.

I CERTIFY THIS SOURCE IS NOT LEAKING

RSO or designee _____ Date _____



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SURVEY METER CALIBRATION CERTIFICATE

Calibration Source Manufacturer _____ Serial No. _____ Activity Assay Date: _____ Radionuclide: _____		Instrument _____ Model _____ Serial No. _____ Probe Type: _____ Probe model / s.n. _____ Owner: _____	
Pulse Generator _____ Serial No. _____ Calibration Due Date: _____			
Battery Check OK <input type="checkbox"/>	Check Source Serial No: _____ Response _____ cpm	Window Open <input type="checkbox"/> Closed <input type="checkbox"/> Fixed <input type="checkbox"/>	
Physical Condition OK <input type="checkbox"/>	Meter Illumination OK <input type="checkbox"/>	Audible Response OK <input type="checkbox"/>	
High Voltage: _____ V	Number of scales: _____	Are repairs required? _____	

SCALE	Pulse Rate ppm	As Found Instrument Reading	After Calibration Instrument Reading	Accepted
SCALE	Activity (Original) dpm	Activity (Today) dpm	Instrument Reading cpm	Efficiency c/d

Calibration Geometry Source to detector distance: 0.25" <input type="checkbox"/> 0.5" <input type="checkbox"/> Contact <input type="checkbox"/>	 HP-210	 Ludlum 44-9
Comments: _____ _____ _____		

Calibration Date: _____
 Calibration Due Date: _____ Calibration Completed by: _____
 Reviewed by: _____ Review Date: _____
 Radiation Safety Officer

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SOURCE DISPOSAL CONTAINER CONTENTS

Authorized User: _____ Department: _____

Nuclide: _____ Physical Form: _____
(One sheet/nuclide unless lot has multiple nuclides) (Solid, Liquid, LSV)

Lot #	Orig. Activity	Lot Assay Date	Fraction of Lot Disposed
1. _____	_____	_____	_____
2. _____	_____	_____	_____
3. _____	_____	_____	_____
4. _____	_____	_____	_____
5. _____	_____	_____	_____
6. _____	_____	_____	_____
7. _____	_____	_____	_____
8. _____	_____	_____	_____
9. _____	_____	_____	_____
10. _____	_____	_____	_____

END DATA: Placed in container # _____ Pick Up Date: _____

(RAM picked up by) Signature: _____

Total Activity: _____ As of Final Disposal Date: _____
(Sent to: Waste Site, Incinerator, DIS, other - Specify)

If liquid please indicate the constituents (chemicals) and volume.

Chemical _____

Volume _____

If any RCRA or TSCA material present, list:

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APPLICATION FOR USE OF RADIOACTIVE MATERIAL

(a) NAME OF APPLICANT, LAST _____ FIRST _____ MI _____

Department _____ Telephone No. _____

HIGHEST COLLEGE DEGREE LEVEL, FIELD, DATE, INSTITUTION

(b) RADIOLOGICAL SAFETY TRAINING AND EXPERIENCE

Safe handling of radioactive material, principles and practices of radiation protection:

1. Where Trained

Duration of Training, Dates

On-the-Job or Formal Course?

Hours

2. Where Trained

Duration of Training, Dates

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On-the-Job or Formal Course?

Hours

RADIOLOGICAL SAFETY TRAINING AND EXPERIENCE

The characteristics of ionizing radiation, units of radiation dose and quantities, radiation detection instrumentation, standardization and monitoring techniques:

1. Where Trained

Duration of Training, Dates

On-the-Job or Formal Course?

Hours

2. Where Trained

Duration of Training, Dates

On-the-Job or Formal Course?

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Hours

Mathematics and calculations basic to the use and measurement of radioactivity:

1. Where Trained

Duration of Training, Dates

On-the-Job or Formal Course?

Hours

2. Where Trained

Duration of Training, Dates

On-the-Job or Formal Course?

Hours

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RADIOLOGICAL SAFETY TRAINING AND EXPERIENCE

Biological hazards of exposure to radiation:

1. Where Trained

Duration of Training, Dates

On-the-Job or Formal Course?

Hours

2. Where Trained

Duration of Training, Dates

On-the-Job or Formal Course?

Hours

(Please attach additional pages if required to give complete information.)

Additional Training and Positions in Radiological Safety

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Please attach a discussion of your anticipated use of the above materials including the following information:

- e. General nature of experimental or teaching protocols and gross hazard evaluation of the experiment or project.
 - f. Anticipated radiation levels and release of radioactive materials to the laboratory/natural environment.
 - g. Proposed monitoring instruments/procedures to be used. Contact the RSO for recommendations for monitoring instrumentation if using a new nuclide.
 - h. Proposed radioactive waste handling/disposal protocols.
 - i. Location; building designation, room number, department in which radioactive material will be used.
 - j. Ventilation: For example, hoods, glove boxes, air handling capacities, filters (if any), etc.
 - k. Radiological protection equipment to be used: e.g., shielding, waste receptacles, trays, absorbent paper, remote-manipulators, etc.
 - l. Building plan (partial) for proposed use location: drawings (plan view) showing hood location, lab bench and sink locations, adjacent rooms, exterior wall(s), and hallways.
 - m. Occupancy of areas: i.e., Do the areas need access restriction? If so, list the occupancy of any other personnel working in the same area and in any adjacent rooms and hallways (above and below also).
-

**THIS FUME HOOD HAS BEEN
CHECKED FOR RADIOACTIVE
CONTAMINATION AND CLEARED
FOR SERVICE OR REPAIR. DO NOT
REMOVE THIS NOTICE OR USE THIS
HOOD.**

**PLACED BY RADIOLOGICAL
SAFETY
CALL EXT. 4226.**

BUILDING, ROOM:_____

SIGNED:_____

DATE:_____

NOTICE:

**THIS ROOM HAS BEEN CHECKED
FOR RADIOACTIVE
CONTAMINATION AND CLEARED
TEMPORARILY FOR CLEANING,
SERVICE OR REPAIR PERSONNEL.**

**PLACED BY RADIOLOGICAL
SAFETY**

CALL EXT. 5-4226

SIGNED: _____

BUILDING, ROOM: _____

DATE: _____

**USER: DO NOT REMOVE THIS NOTICE
OR USE RADIOACTIVE MATERIALS IN
THIS ROOM UNTIL EXPIRATION DATE:**

____DATE: _____

OR

____Notified by RSO

RADIATION SAFETY OFFICE

4505 MARYLAND PARKWAY, LAS VEGAS, NEVADA 89154-1042
(702) 895-4226

UNLV Procedure for Bioassay Participants

Participant Name _____ UNLV ID # _____

In order to determine if you have received an internal radiation dose, an analysis will be made of the levels of selected radionuclides in your urine. Please carefully follow the instructions listed below regarding collection of the urine sample. Also, complete the questions on this form regarding your use of radioactive material and your past history of bioassays.

Instructions

1. The sample needed for this analysis is total urine output in a 24-hour period. Start the sampling period immediately after a time when you have voided your bladder. Record the start date and time below.
2. Begin collecting urine the next time you void your bladder and collect all output during the next 24 hours. At the end of the 24 hour period collect a final void. Record the end date and time below.
3. Do not take this container into any radioactive material laboratory.
4. Contamination of the sample must be avoided. It is imperative that you wash your hands each time you collect urine. Do not touch the inside of the cap or container or allow foreign material to enter.
5. Fill the container to the shoulder leaving a 0.5 inch air space at the top. Screw the top on securely each time.
6. Minimum sample volume required is 1.0 liters. It is not necessary to refrigerate the sample.
7. Each container must be labeled providing your name, date and time of collection. Place the provided security seal over the bottle cap after each container is filled.
8. Provide the Authorized User/lab manager with your completed samples.

Participant Information The information provided below is important. Please be as accurate as possible.

1. Collection Period: Start Date _____ Start Time _____ End Date _____ End Time _____
2. Sample amount: Number of bottles submitted _____ (Total)
3. Use of radioactive material: List the radionuclides used and describe the time period and frequency.

Radionuclide	Time Period (from / to)	Maximum Amount	Location and Frequency

4. Have you provided bioassay samples for internal dose assessments to organizations other than UNLV? Yes / No
If Yes, When _____
Facility/Location/Address _____
What radionuclide(s) _____

Chain of Custody

Please sign and date the Chain of Custody when relinquishing or accepting samples.

Relinquish by: _____ (sign) Date: _____ Accepted by : _____ (sign) Date: _____
 Relinquish by: _____ (sign) Date: _____ Accepted by : _____ (sign) Date: _____
 Relinquish by: _____ (sign) Date: _____ Accepted by : _____ (sign) Date: _____
 Relinquish by: _____ (sign) Date: _____ Accepted by : _____ (sign) Date: _____

RADIATION SAFETY OFFICE

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(702) 895-4226

UNLV Procedure for Bioassay Participants

Participant Name _____

UNLV ID # _____

In order to determine if you have received an internal radiation dose, an analysis will be made of the levels of selected radionuclides in your feces. Please carefully follow the instructions listed below regarding collection of the fecal sample. Complete the questions on this form regarding your use of radioactive material and your past history of bioassays.

Instructions

1. Contamination of the sample must be avoided.
2. It is imperative that you wash your hands each time you collect a sample. Do not touch the inside of the lid or container or allow foreign material to enter.
3. Do not collect a sample or store this container in any radioactive material area.
4. The sample needed for this analysis is fecal output in a 24-hour period. Start the sampling period and record the start date and time below and on the provided container sample label, including your name and UNLV I.D.
5. Don't overfill the sample container. Record the sample end date and time below and on the sample label.
6. Refrigerate the sample during use and freeze after completion, if possible. Remember, the sample is considered a bio-hazard.
7. Provide the Authorized User/lab manager with your completed samples.
8. Sign and date the Chain of Custody section below, on the "Relinquished by" line.

Participant Information The information provided below is important. Please be as accurate as possible.

1. Collection Period: Start Date _____ Start Time _____ End Date _____ End Time _____
2. Use of radioactive material: List the radionuclides used and describe the time period and frequency.

Radionuclide	Time Period (from / to)	Maximum Amount	Location and Frequency

3. Have you provided bioassay samples for internal dose assessments to organizations other than UNLV? Yes / No
If Yes, When _____
Facility/Location/Address _____
What radionuclide(s) _____

Chain of Custody

Please sign and date the Chain of Custody when relinquishing or accepting samples.

Relinquish by: _____ (sign) Date: _____

Accepted by : _____ (sign) Date: _____

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STATE OF NEVADA – HEALTH DIVISION

NOTICE TO EMPLOYEES

STANDARDS FOR PROTECTION AGAINST RADIATION, NOTICES, INSTRUCTIONS AND REPORTS TO WORKERS, INSPECTIONS

The Nevada State Board of Health has established standards for the protection from exposure to radiation for all persons who are working under a license or registration issued by the Health Division authorizing the use of radioactive material or X-ray machines. These standards are included in regulations defined as Sections 459.010–459.950, inclusive, of Chapter 459 of the Nevada Administrative Code.

YOUR EMPLOYER'S RESPONSIBILITY

Your employer is required to:

- 1. Apply these regulations to work involving sources of radiation.
2. Post or otherwise make available to you a copy of the Health Division regulations for protection from radiation, a complete copy of the license certificate of registration, and the operating procedures which apply to work you are engaged in and explain their provisions to you.
3. Post Notice of Violation or order involving noncompliance with regulations for protection from radiation in the work place
4. Post your letter of reply to notices of noncompliance with the regulations.

any applicable limit set forth in the regulations. The limits in the regulations apply both to external exposures to radiation and internal exposures to airborne radioactive materials.

- 2. If you work where the monitoring of personnel for exposure to radiation or radioactive material is required:
(a) Your employer must provide you with an annual report of your exposure to radiation or radioactive material; and
(b) Upon termination of your employment, your employer must you with a written record of your total exposure to radiation for each year, or portion thereof, during the period you worked at facility.

YOUR RESPONSIBILITY AS A WORKER

You should familiarize yourself with the provisions of the Health Division regulations for protection from radiation and the operating procedures that apply to your job. You should strictly comply with all the provisions of the regulations for your own safety and for the safety of those persons who work with you.

INSPECTIONS

All licensed or registered activities are subject to inspection by representatives of the Health Division. In addition, any worker or representative of workers who believes that there is a violation of the Nevada Revised Statutes, Chapter 459, the regulations issued thereunder, or the terms of the employer's license or with regard to radiological working conditions in which the worker is engaged, request an inspection by sending a notice of the alleged violations to the Health Division. The request must set forth the specific grounds for the notice and must signed by the worker or the representative of the workers. During Health Division inspectors may confer privately with workers, and any may bring to the attention of the inspectors any past or present condition which he/she believes contributed to or caused any violation as described above.

WHAT IS COVERED BY THESE REGULATIONS

- 1. Limits on exposure to radiation and radioactive material in restricted and unrestricted areas;
2. Measures to be taken after accidental exposure;
3. Personnel monitoring, surveys and equipment;
4. Caution signs, labels and safety interlock equipment;
5. Exposure records and reports;
6. Options for workers regarding Health Division inspections; and
7. Related matters.

INQUIRIES

Inquiries dealing with matters outlined above can be sent to: Radiation Control Program, Bureau of Health Care Quality & Compliance, Nevada State Health Division, 727 Fairview Drive, Suite E, Carson City, Nevada 89701.

REPORTS ON YOUR RADIATION EXPOSURE HISTORY

- 1. The Health Division regulations for protection from radiation require that your employer give you a written report if you receive an exposure in excess of

POSTING REQUIREMENT

COPIES OF THIS NOTICE MUST BE POSTED IN A SUFFICIENT NUMBER OF PLACES IN EVERY ESTABLISHMENT WHERE EMPLOYEES ARE WORKING WITH SOURCES OF RADIATION THAT ARE LICENSED OR REGISTERED BY THE HEALTH DIVISION TO PERMIT EMPLOYEES WORKING IN OR FREQUENTING ANY PORTION OF A RESTRICTED AREA TO OBSERVE A COPY ON THE WAY TO OR FROM THEIR WORK STATION.

http://www.leg.state.nv.us/nac/nac-459.html