RADIATION SAFETY MANUAL

UNIVERSITY OF NEVADA, RENO

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PREFACE

This Radiation Safety Manual contains the policy, regulations, and recommended procedures for the safe use of radiation sources at the University of Nevada, Reno. It is incorporated as a condition of license issued to the University by the State of Nevada Radiation Control Program of the Department of Human Resources and is the governing document which must be adhered to by all users of radiation. Although overall responsibility for radiation safety rests with the University, basic responsibility for protection of life and property must remain with the individual user of the radiation source. Thus, this individual must possess certain acceptable qualifications and follow designated policies and required procedures as outlined in this manual.

Mridul Gautam
Vice President for Research and Innovation

3/19/15
Date

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1.0 Introduction

Radionuclides used in research, industry, education and medicine are valuable assets which can benefit man 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.

This Manual describes the applicable regulations, policies, and procedures on which the University of Nevada, Reno (UNR) 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.

The University of Nevada, Reno is licensed by the Radiation Control Program Office of the Nevada State Health Division. Radiation sources at UNR are regulated by the State Radiation Control Program Office in accordance with the provisions of NAC 459.

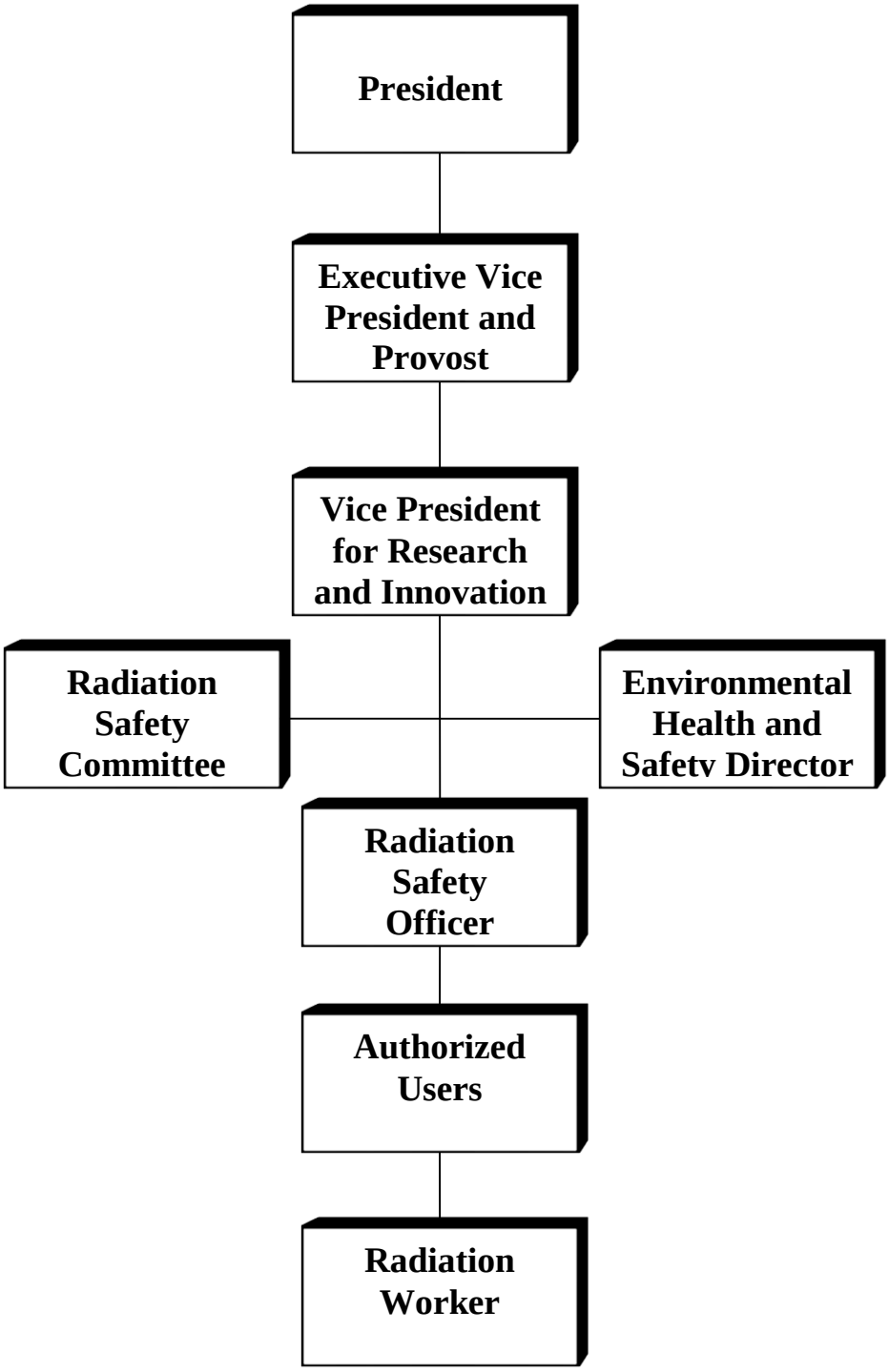
The University of Nevada, Reno established the Radiation Safety Committee (RSC) and the Environmental Health and Safety (EH&S) Department for the accountability of radioactive materials and to minimize the exposure of people to radiation.

This Radiation Safety Manual describes the organization and responsibilities outlined in UNR's comprehensive radiation safety program, including the radiation 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 RSC. Any additions and/or modifications must be approved by the State Radiation Control Program Office. Changes will occur as revisions or additions to this manual become necessary for purposes of clarification, changes in title or positions, and other reasons which in no way shall result in a lessening of the safe use of radiation sources.)

2.0 ORGANIZATION/RESPONSBILITY & AUTHORITY

2.1 ORGANIZATION CHART



UNR's Radiation Safety Program consists of the Radiation Safety Committee, the Environmental Health and Safety Department, the Radiation Safety Office, the Authorized User and the Radiation Worker.

2.2 RESPONSIBILTIY AND AUTHORITY

2.2.1 Radiation Safety Committee (RSC)

The RSC receives its authority from the UNR President through the Vice President for Research and Innovation.

Membership

The RSC is appointed by the Executive Vice President and Provost and advises him/her on all matters relating to radiation safety. The committee includes the Radiation Safety Officer (RSO); a representative of management; and members who represent broad areas or divisions of UNR which are likely to use radiation sources. The RSO is a permanent member of the RSC and of all of its subcommittees.

Responsibility

The RSC establishes appropriate policies and procedures to ensure control of the procurement and use of radioactive materials and radiation emitting devices.

The RSC oversees UNR's compliance with all applicable government regulations.

The RSC meets as often as necessary, but no less than quarterly.

The RSC reviews and approves/disapproves new radiation use applications. The committee delegates its authority to the RSO to review and approve/disapprove requests of a routine nature relating to the use of radiation sources.

The RSC may suspend radiation use authorization when necessary.

The RSC may apply conditions and/or restrictions to the proposed radiation use.

The RSC may delegate authority to various persons and subcommittees with specific expertise in areas under their review.

2.2.2 Environmental Health and Safety

The day-to-day operation of the Radiation Safety Program is managed by the Radiation Safety Office which includes the Radiation Safety Officer. The Radiation Safety Office is a component of the Environmental Health and Safety Department.

2.2.2.1 Services provided by EH&S 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.

2.2.3 Radiation Safety Officer (RSO)

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

The RSO is the RSC's authorized representative regarding radiation safety within the jurisdiction of UNR's radioactive material license.

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 any standing committees, 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 central administration, and when appropriate, to regulatory authorities.

2.2.4 Authorized User (AU)

Authorized Users are faculty or staff members who have been approved to use radioactive materials or radiation emitting devices by the RSC. Authorized Users radiation use must follow the approved procedures and conditions stated in the authorization. Authorized user permits are granted for 5 years based on evaluation of the radiation safety record by the RSO. The user must reapply for the new user permit before the current permit expires.

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 UNR Policy. He/she must be aware of the radiation hazards associated with the activity of the materials in use and the procedures specified in the project authorization.

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

2.2.5 Radiation Worker

A radiation worker is anyone who uses radioactive materials (RAM) or radiation producing machines and has received 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 attend annual radiation safety refresher courses.
- Comply with the all applicable regulations, UNR Radiation Safety Manual, and policies and procedures, and conditions in the Radiation Use Authorization (RUA).
- Be familiar with all the RAM used in the facility, their uses, physical and radiological properties, and safety precautions.
- Handle RAM and all radiation sources in a responsible manner to maintain occupational radiation exposure As Low As Reasonably Achievable (ALARA).
- Secure RAM to prevent unauthorized access. RAM must be under immediate supervision of the radiation worker within the laboratory or be stored locked when not in use.
- Notify the EH&S of any emergency or incident involving RAM.

3.0 OCCUPATIONAL DOSE LIMITS AND CONTAMINATION STANDARDS

3.1 Occupational dose limits

It is UNR policy to maintain human radiation exposure levels to "As Low As Reasonably Achievable" (ALARA). In any area accessible to any person, radiation levels shall not exceed 0.002 rem (0.02 mSv) in one hour or 0.05 rem (0.5 mSv) in one year at 30 cm from the source of radiation or from any surface that the radiation penetrates.

UNR Annual Limits for Radiation Exposure	
Total Effective Dose Equivalent	5000 mrem (0.05 Sv)
Skin and extremities	50000 mrem (0.50 Sv)
Lens of eye	15000 mrem (0.15 Sv)
Declared pregnant worker	500 mrem (0.005 Sv)
Minors	500 mrem (0.005 Sv)
General public	100 mrem (0.001 Sv)

UNR administrative 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 limits are the same as the regulatory occupational limits.

3.2 CONTAMINATION STANDARDS

The administrative permissible levels of contamination are listed below. It is UNR'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/100 cm^2	Beta and gamma emitter/100 cm^2
Uncontrolled	11 dpm	100 dpm
Controlled	22 dpm	550 dpm
Restricted	110 dpm	1100 dpm

4.0 HANDLING POLICIES

4.1 Safe Work Practices

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

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

Locate work areas away from heavy traffic or doorways.

When moving a radioactive solution between approved locations, place the material in a secondary container.

4.2 Radiation Safety Training

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

- Radiation safety training is provided through the EH&S Program. The AU provides training in laboratory specific policies and procedures for associated radiation workers. Annual refresher training is required.

- The training requirement may be waived by the RSO for personnel who have either received training from other institutions (and the evidence of training is provided to RSO). Training may also be waived if an individual has previously worked with RAM.

- Classroom training requirements for ionizing radiation can be met by the RSO, by another approved instructor, or by a member of the Radiation Safety Staff. Radiation safety guidelines will be presented before laboratory work begins. Documentation of

this training must be on file by the AU with all other required papers and sent to EH&S to be kept on file.

Temporary radiation workers can be approved by the RSO.

- Temporary radiation workers (radiation work period less than or equal to two weeks) may use RAM under the direct supervision of the AU or another radiation worker who is familiar with the RAM use in the laboratory. Radiation safety training is recommended, but it is not mandatory.

4.3 Radiation Use by Pregnant Women

It is the policy of UNR to assure that the unborn children of UNR's employees 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.

4.4 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.**

4.5 Labeling of Containers

Containers of radioactive material for storage, processing, or use, shall be individually and conspicuously labeled "Caution-Radioactive Material". Exempt containers 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 quantities 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.

4.6 POSTING OF RADIATION AREAS

4.6.1 Rooms and Work Areas

All rooms in which more than exempted quantities or exempted concentrations of radioactive

materials are used or stored shall be designated in writing by the RSO and shall be posted with an appropriate warning label. Radiation sources must not be in any room or location that has not been approved by the RSO.

4.6.2 Controlled Areas

All areas with greater than exempted quantities or exempted 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. Casual visitors are prohibited in controlled areas.

4.6.3 Notice to Employees

The State Radiation Control Program Office Form NRC-1 "Notice to Employees" shall be conspicuously posted in each laboratory where radioactive materials are used.

4.6.4 Radiation Laboratory Rules

Each laboratory using radionuclides shall conspicuously post the UNR "Radiation Laboratory Rules" (APPENDIX B).

4.7 Protective Clothing Policy

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

4.8 Storage and Consumption of Food, Smoking, and Application of Cosmetics Policy

The storage and consumption of food, smoking, and application of cosmetics is prohibited in locations authorized for the storage and use of radioactive materials. Clean areas in this section mean the absence of radioactive material or radiation sources. All other hazards such as chemical hazards must be addressed by EH&S.

Upon the request of the Authorized User, "Clean Areas" may be designated by the Radiation Safety Office after radiation and/or contamination surveys of the area have been conducted by the Radiation Safety Office. 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, and the types of operations being conducted.

Refrigerators used for storage of radioactive materials shall not be used for storage of food and beverages. If an Authorized User wishes to use a refrigerator for food storage that was

previously used for storage of radioactive materials, it must be surveyed by the Radiation Safety Staff and verified as clean. Only then can it be used for food storage in unrestricted areas.

4.9 Personal Hygiene

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

4.10 General Monitoring

4.10.1 User

Immediately following the use of radioactive materials, the area and equipment must be swiped (and the swipes counted) or surveyed, by an appropriate method for the radioisotope(s) in use by personnel directly involved with the project. Monitoring results must be documented and the records must be preserved. Monitoring may be required more frequently at the discretion of the RSO. If contamination is found, the Authorized User must immediately restrict access to the area and decontaminate the area.

Each laboratory in which radioisotopes are used shall be equipped with a portable survey instrument in good working order which is capable of detecting the type of radiation(s) emitted by the radioisotope(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 and analysis by a liquid scintillation counter are required when H-3 isused. All portable radiation survey equipment will be calibrated, and all fixed counting equipment 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 both with the equipment and at the Radiation Safety Office.

4.10.2 Radiation Safety Office

The RSO and/or other qualified EH&S personnel shall also conduct periodic surveys of all areas in which licensed radioactive material is used. The RSO 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.

5.0 ANIMAL USE POLICY

5.1 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 which receive radioisotopes must be properly identified and controlled. Approval from the Radiation Safety Office will be required prior to relocation of any such animal.

5.2 Contamination Control

Radioactive excreta, animal carcasses and tissues, contaminated cage bedding, etc., are handled in accordance with radioactive waste disposal procedures. Prior to the start of work, 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, to ensure that facilities to be used are adequate.

5.3 Instruction of Animal Care Providers

The Authorized User is responsible for ensuring that animal care providers and handlers are given 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 for the animals 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 EH&S Department.

6.0 PROCEDURE FOR OBTAINING RADIATION USE AUTHORIZATION (RUA)

Before an individual may use radioactive sources for purposes of teaching, research, etc., a 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 form.

6.1 Definition

A RUA is a written approval from the RSC to an individual for the purpose of ordering, purchasing, possessing and using radioisotopes. Radiation use application forms are available from the EH&S webpage.

6.2 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 who can fulfill the requirements in section 2.2.4 of this Radiation Safety Manual, may apply for a RUA.

6.3 Responsibilities and Requirements of Authorized Users

The Authorized User is responsible for the safe use of the radiation source(s), and STRICT compliance with the contents of this manual, the provisions and requirements of NAC 459, and the university radioactive materials license. He/she must insure 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 UNR Radiation Safety Manual and the Laboratory Animal Medicine Department.

6.4 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. This information will be reviewed by the RSO to ensure that the University does not exceed the quantity specified in the UNR license. If the amount desired will cause the University to exceed the amount specified in the UNR radioactive material license a request for a license amendment will have to be made to the State in order to proceed with the authorization. This will lengthen the time to approve the RUA.
5. General nature of the experimental or teaching protocols and gross hazard evaluation of the experiment or project.
6. Anticipated radiation levels and release of radioactive material to the laboratory/natural environment.
7. Proposed monitoring instruments/procedures to be used. If in doubt, contact the RSO for recommendations for monitoring instrumentation.
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: 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 chair approval to apply for the use of radioactive materials.

6.5 Approval of the RUA Application

Completed applications shall be submitted to the Radiation Safety Officer for review and approval by the RSC.

It is recognized that "Exempt" quantities of radioisotopes can be obtained without a specific license. However, in order to keep an accurate radioisotope inventory (as required by regulations) and to review any proposed uses of ionizing radiation at UNR, it is required that an

RUA be approved prior to any purchases of "Exempt" quantity of radioactive materials (i.e., check sources, etc.).

7.0 PROCEDURE TO OBTAIN CLASSROOM USE AUTHORIZATION (CUA)

7.1 Definition

Authorizations for use of radiation emitting materials for teaching or demonstrations in academic courses are normally valid for one or two semesters based on the class set up. Classroom Use Authorization requests shall be submitted to the RSO for review and approval by the RSC. Annual renewals are required. Any student handling radiation sources must be under the **direct supervision** of the Authorized User.

7.2 Safety Precautions

As a condition of approval, the RSC may require special safety measures, equipment and/or procedures to be used.

The individuals responsible must keep the RSC informed of changes in CUA procedures or personnel, or modifications in the device or facilities which could affect radiation safety.

The RSO will conduct surveys and audits (at intervals not to exceed 3 months) to assure safety and compliance.

Whenever, in the RSO's professional judgment, continued operation poses a danger to any person, the RSO may restrict, modify or terminate any CUA immediately.

7.3 Procedure

All the applicable information in Chapter 7 is required for a CUA application. In addition, the following information is required to supplement the standard RUA request:

1. Name of laboratory instructor in charge, if other than applicant, and his/her experience using radiation;
2. Names and experience of laboratory or teaching assistant(s) involved in the course;
3. Duration of course;
4. Number of students anticipated; (forward names, birth dates, and social security numbers for all students immediately after term begins);
5. Course number and title;
6. Number and type of monitoring instruments available in the laboratory for routine use;
7. Description of proposed use and radiation protection measures to be used for each isotope stated in the CUA request, including:
   (A) Safety instruction for students;
   (B) Extent to which students will be handling radioisotopes and radiation producing machines.

NOTE: Student handling of radiation sources will be kept to the absolute minimum and only be done using appropriate remote handling devices or manipulators where applicable.

8.0 RADIATION SOURCE CONTROL PROCEDURE

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

8.1 Procurement Procedure

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 registration of the material, and direct communication between the prospective user and the Radiation Safety Office. No radioactive materials or ionizing radiation sources, including "Exempt quantities," will be purchased without RSO approval.

8.2 Receipt Procedure

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

Once the initial survey is completed, recommendations for handling the source will be provided by the Radiation Safety staff. In the event that the material cannot be delivered to the Central Service Building, a representative of the Radiation Safety Office will provide similar checks at the point of delivery. Upon completion of this check, the AU will be notified and arrangements for delivery or storage will be made.

Radiation source shipments will not be accepted outside of university business hours unless special arrangements are made with the RSO prior to receipt of the shipment.

8.2.1 Responsibilities of Receiving Personnel:

1. Inspecting packages labeled “Radioactive Materials” IMMEDIATELY upon receipt.
2. Not accepting damaged packages(s), i.e., leaking or torn. Detain driver and call the EH&S Office (327-5040) immediately.
3. Placing packages in designated storage area.
4. Notifying EH&S at 327-5040.

8.2.2 Responsibilities of Radiation Safety Personnel:

1. Removing packages from "Central Receiving" and transporting them to the Radiation Safety laboratory.
2. Monitoring packages for external radiation levels using appropriate instrument(s).

    a. Check radiation level at 1 m from package. This level must be equal or less than the transport index (TI) on the shipping label. If the radiation level is higher than 20% of the TI, secure source and contact the RSO immediately.
    b. Check radiation level at surface of package.

3. Wipe testing external surfaces of the packages for removable contamination.
4. 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.
5. Measuring radiation levels of containers. [NOTE: Utilize shielding material and remote handling tools where appropriate.]
6. Checking for possible breakage of seals on containers, loss of liquid, or change in color of absorbing materials.
7. Wipe testing inner contents and documenting findings on the packing slips. [NOTE: The liner, shield and isotope container may have surface contamination; if contaminated, they should be discarded in radioactive waste disposal containers.]
8. Recording type of activity, quantity present and location of delivery in the Radiation Safety Office receiving log.
9. Notifying the vendor(s) immediately if beta or gamma contamination in excess of 2200dpm/100 cm^2 or alpha contamination in excess of 220dpm/100 cm^2 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.
10. Notifying the Authorized Users and delivering all packages following Radiation Safety Office inspection.

8.3 Sources Received Gratis

1. When the procurement procedure does not involve the Purchasing Department the following procedures must be followed:
2. Individuals obtaining gratis radioactive materials must notify and request permission and instructions from the RSO.
3. The individual must determine and certify that this acquisition will not cause the user to possess any radionuclide exceeding his/her authorized quantity.
4. The isotopes must be delivered to the RSO for processing in accordance with the provisions of the previous section.

8.4 Transfer Procedure

The Authorized User of a radiation source 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 chapter 3.

Advice and assistance will be provided for all shipments of radiation sources from UNR. These shipments must receive prior WRITTEN approval from the RSO. Questions concerning transportation and packaging should be referred to the RSO.

8.5 Waste Pickup and Disposal

Disposal of radiation emitting materials and devices requires written approval of the Radiation Safety Officer. Waste pick-up and disposal services are described in APPENDIX C. 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 without EH&S approval.
   b) Incineration of radioactive waste at UNR is prohibited.
   c) Radioactive labels or signs or tapes which are not radioactive must not be the placed in P-32 radioactive waste.
   d) Short half-life radioactive waste ($T_{1/2}$ less than 15 days) and all others radioactive waste must be separated.
   e) When waste containers are full, perform radiation surveys and swipe outside surface for removable 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. EH&S will not pick-up improper and unsafely packaged radioactive material waste.

Note: Do not seal the container. The container must be inspected by Radiation Safety staff.

8.6 Inventory of Radiation Sources

In order to maintain proper control of radiation sources and to meet university license requirements, it is necessary to compile bi-annual inventories of all radiation sources. Inventory reports are due at the Radiation Safety Office by the close of business on the 10th work day after each of the following dates: March 31, and September 30.

8.7 Reporting Frequency Requirements

1. Bi-annual inventory must be performed and a report submitted to the RSO by all Authorized Users (negative reports are required)
2. An annual physical inventory of all radiation sources must be conducted.
3. Failure to submit the required inventories may result in suspension of the User's

Authorization until such time as he/she assures the RSO that appropriate procedures are in place to prevent such problems from recurring.

THIS INVENTORY MUST INCLUDE THE FOLLOWING INFORMATION:

1. Physical location of source - room number and location in lab (refrigerator, fume hood, etc.)
2. Source description
3. Original activity or radiation emission rate and date or current activity as of the date of the inventory
4. Disposition of material if not in storage
5. Possession limit of user

NOTE 1: Inventory forms for recording the above information may be obtained from the EH&S web page.

NOTE 2: All inventory forms must bear an original signature (or electronic signature) and date.

8.8 Labeling of Radiation Sources

Except for quantities less than values listed in NAC 459.186 or NAC 459.188, each individual radiation source or container shall be labeled with an identification tag, clearly indicating the date, radionuclide, and quantity. Labels are available from EH&S. All tags or labels shall be removed/replaced when the information on them is no longer applicable.

9.0 CONTAMINATION CONTROL PROCEDURES

Radioactive contamination control can be affected by proper handling of radioactive material, the use of adequate protective clothing, and the use of sealed containers for transfer and storage of such material. THE FOLLOWING STEPS WILL HELP TO PRVENT 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
3. Worn by all individuals working in the area

C. Swipe tests will be taken to evaluate the level of removal contamination according to Chapter 10 of this manual.

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 Chapter 17 of this manual.

10.0 RADIATION AND CONTAMINATION SURVEYS

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.

10.1 Authorized Users

It is the responsibility of individual Users to perform appropriate radiation and/or contamination surveys in areas where radiation or radioactive contamination may exist. Procedures/facilities involving high potential for contamination/radiation to be present will be surveyed by the Authorized User during or immediately following radioactive material/radiation use. These surveys must be documented whenever the area has been in use. As a general policy, individual users are required to obtain suitable equipment for their own monitoring needs. The RSO will advise the Authorized Users in the selection and correct use of their instrumentation. The Radiation Safety Office 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. It should be noted, that improper use of instruments may lead to misinterpretation of the hazards which could result in excessive and unnecessary radiation exposures.

10.1.1 Smear or Swipe Surveys

The most effective method for detecting removable contamination is to take smears in work areas >100 cm^2 per smear, etc., using filter papers. The smears are then counted in a suitable detection system approved by the RSO, (i.e., for H-3 a liquid scintillation counter is used). The resulting counts give an indication of the levels of contamination. If contamination is found, decontaminate the area and repeat smear surveys. All findings, actions taken to decontaminate, and the final swipe test results must be documented. Contact EH&S if contamination persists.

10.1.2 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 establish that 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 the 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 area such as hallways, rooms next to and directly above and below except designated radiation areas.

10.2 Radiation Safety Office

The Radiation Safety Staff will conduct appropriate radiation and/or contamination (smear) survey inspections within each laboratory/facility at intervals of at least every 6 months. An inspection form should be used for surveys and will become the written report that will be placed on file in the EH&S Office.

The routine inspections will require a site visit to ensure that all provisions of this Radiation Safety Manual are carried out and that radiation and surface contamination levels are within the UNR Administrative Limits.

10.3 Reporting of Survey Findings

1. A copy of the inspection report will be sent to the Authorized User. Matters requiring immediate action, such as removable contamination, 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.

11.0 RECORD KEEPING PROCEDURES

It is a legal requirement inherent in UNR's radioactive material license that certain records be maintained and made available to authorities. In accordance with this requirement and as part of good radiation safety practice, the EH&S program requires that the following information be recorded:

11.1 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 Chapter 10 (Radiation & Contamination Surveys).

11.2 Records Maintained by EH&S:

- Current inventories of all radiation emitting materials and devices
- Radiation survey results and monitoring data
- All incidents (spills, releases, contamination problems) involving radiation sources, including investigation and resolution reports
- Leak test data on all sealed radiation sources
- Personnel monitoring results, and investigation and resolution reports in all cases of measurements exceeding administrative ALARA limits

- Instrument calibration results
- Waste disposal records
- License information
- Emergency equipment inventories and readiness inspections
- Radiation Safety Committee and Subcommittee meeting agendas and minutes
- Authorization applications, authorizations, and list of current Authorized Users
- Deficiency citations and related documentation

12.0 SEALED SOURCE USE PROCEDURES

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.

12.1 Sealed Source Use Procedure

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 (dosimeters) is provided by EH&S 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 with a calibrated detector shall be conducted of all general use areas to determine radiation levels. The radiation level in an uncontrolled area shall be less than 2 mrem/hr and 50 mrem/yr. Records shall be maintained of these surveys.
4. Mark the use area with the appropriate caution signs as specified in NAC 459.355-3575.
5. Post State Radiation Control Program Office Form NRC-1 "Notice to Employees."
6. Sources must be secured from unauthorized access or be attended at all times.
7. Leak testing of each sealed source not exempted from licensing shall be performed in accordance with Chapter 17 of this Manual.
8. Notify EH&S <u>immediately</u> 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 uCi or more of removable contamination), the Radiation Safety Staff will remove the source from use until properly resealed. A report will be filed with the State Radiation Control Program Office within five days (NAC 459.307). Sources found with detectable amount of removable contamination will be examined, cleaned, and resurveyed. If necessary, a qualified outside vendor will be called for repair and/or maintenance of a source. 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 provided to, and maintained by, the EH&S Department.

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

13.0 IODINATION PROCEDURE I-125 and I-131

1. Vials or other containers of radioiodine must be opened only in a hood or glove box approved by the RSO.
2. During iodination all operations must be conducted in an approved hood or glove box. The hood or glove box must be equipped with charcoal filters to prevent significant release of radioiodine to the environment.
3. Protective clothing must be worn, including a minimum of a laboratory coat, impervious gloves, and safety glasses.
4. The operator and the work area must be monitored immediately following completion of work. Any contaminated areas must be fully decontaminated immediately. A thin window GM or thin crystal scintillation probe is desirable for such monitoring.
5. Liquid waste may be stored temporarily in tightly closed containers, preferably in a hood. Solid wastes should be stored in closed plastic bags in an appropriate waste container.

14.0 INSTRUMENTATION AND EQUIPMENT

14.1 Radiation Detection Equipment

Authorized users must equip their laboratories with the appropriate survey instruments in good working order for each radioactive material use laboratory/facility.

The Radiation Safety Office is responsible for performing, or having performed, all portable radiation measuring instrument calibrations. The Authorized User is responsible for performing operability, and when appropriate, efficiency checks, on the equipment in their facilities/laboratories. All radiation measuring equipment must be calibrated annually.

GM and beta scintillation detectors are useful for monitoring medium-to-high energy beta radiation. These detectors are not capable of detecting H-3 due to its low beta energy. Liquid scintillation counters are used to monitor H-3. Gamma scintillation detectors are used to detect low-to-high energy gamma and x-rays.

Commonly used RAM at UNR

Radionuclide	Radioactive half-life	Radiation type, energy level	Exposure rate at 1 foot from 1 mCi 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	14.3 days	Beta, high	300 mrad/hr	Plexiglas/plastic
S-35	87 days	Beta, medium	Low	None
Ca-45	162.7 days	Beta, medium	Low	None
Sc-46	83.8 days	Gamma, high	12 mR/hr	Lead
Cr-51	27.7 days	Gamma, medium	0.2 mR/hr	Lead
Fe-59	44.5 days	Gamma, high	7 mR/hr	Lead
I-125	60 days	Gamma & x-ray, low	0.8 mR/hr	Lead, leaded glass or plastic
I-131	8.3 days	Gamma, medium	2.4 mR/hr	lead

Detectors and their applications

Detector type	Radiation to detect			Radionuclides to detect	Portability
	A	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 UNR except H-3	Yes
GM, Thin end	Yes	yes	yes	Most RAMs used at UNR except H-3	Yes
Beta scintillation		yes		C-14, P-32, P-33, S-35, Ca-45,	yes
Beta-gamma scintillation		yes	yes	C-14, P-32, P-33, S-35, Ca-45, Sc-46, Cr-51, I-125, I-131	yes
Ion chamber			yes	Gamma (beta if equipped) exposure rate,	Yes
Liquid scintillation analyzer	Yes	yes	yes	All RAM used at UNR including H-3	Fixed
Gas Proportional counter	Yes	Yes	yes	All RAM used at UNR	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%

15.0 SOURCE STORAGE PROCEDURES

All radiation sources must be stored in a secured location (restricted access, minimum fire hazard, approved ventilation, sufficient shielding), labeled, and the location posted with a "Caution Radioactive Material" sign. The EH&S Department will provide the proper signs and surveys to ensure compliance with the posting requirements of NAC 459.355-3575.

1) Sources which 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 EH&S.
3) Radiation sources 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 50 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) Biannual radiation surveys of the storage area shall be made by the Radiation Safety Office. 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 and 50 mrem/yr at 30 cm (1 foot) from the shield including the areas behind, above or below the shield. Make sure the 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 allow 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) A compartmentalized shield (use partitions or smaller shipping shields) will reduce exposure to the aggregate of the sources.
11) Use a plastic box or another 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 pipet, tongs, gloves, etc.) conveniently.
14) Store radioactive liquids in unbreakable containers or in secondary containers to prevent spillage.
15) Shield radioactive wastes in storage that are awaiting pickup so that radiation levels at 30 cm from the surface do not exceed 2 mR/hr.

16.0 RESTRICTED AREA DESIGNATION PROCEDURE

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. Each individual working or visiting such areas must carefully observe signs and directions indicating the action to be taken in a specified area.

16.1 Unrestricted Area:

No contamination or significant radiation levels exist. Personnel monitoring is not required.

16.2 Restricted Area:

Personnel monitoring may be required. If required, protective clothing requirements shall be clearly posted. Caution is to be exercised. Some examples are:

16.2.1 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 which could result in a person receiving a dose equivalent in excess of 0.005 rem in an hour at 30 centimeters from the source of radiation or from any surface that the radiation penetrates."

16.2.2 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."

16.3 Contaminated Area

Controlled access only for purpose of contamination control and decontamination activities. Persons must not enter such an area without a specific reason to be there, authorization and proper personal protection.

16.4 Authorized Personnel Only

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. If an individual does enter a Controlled Area accidentally, he/she must exit the area and notify EH&S, taking care not to wander far from the area so as to prevent possible spread of contamination.

17.0 LEAK TEST PROCEDURES

17.1 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 which are likely to be encountered in normal use and handling.

17.2 General Requirements

The EH&S Department is responsible for ensuring that all sealed sources are leak tested 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.

17.3 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 that 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.

17.4 Procedures

The leak test may be performed in the following manner:

1. The Authorized User or RS personnel performs the test following a preapproved method and notifies the RSO of the results in writing.
2. Wipe the source or the area closest to the source using a swab or filter paper. Refer to Leak Test Procedure and use a calibrated instrument for analysis. The wipes are sent 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 to perform both the wipe tests and analysis. The RSO will then send a written report to the Authorized User for his/her files.

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

18.0 PERSONNEL MONITORING

Personal monitoring is required for the persons who are likely to receive a dose in excess of the UNR's administrative limits or 10% of state occupational dose limits.

18.1 How to Obtain a Dosimeter

Anyone who received radiation safety training and who is likely to receive 10% of the state occupational dose limits may request personal monitoring. The requesting personnel must complete the dosimeter request form and send it to EH&S. The dosimeter request form is available from the EH&S web page and office. Dosimeter delivery may take one week to two weeks from receipt of dosimeter request form.

NOTE: Those persons wishing to provide dosimetry to their students for class or laboratory activities must make special arrangements with EH&S.

18.2 Personal Dosimeter Use Procedure

1) Dosimeters will be worn ONLY by persons to whom they are issued. They must NOT be loaned to another person, nor used for area monitoring. (Area monitoring is available from EH&S).
2) The whole body dosimeters should be worn in the central chest region.
3) Ring or wrist dosimeters are issued to persons who use a high energy beta source. Ring dosimeters should be worn on the finger which 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. Do not wear a dosimeter when undergoing medical or dental diagnosis or therapy, since your non-occupational dose is not regulated by the State Radiation Control Program Office, and is not to be included as part of your dosimetry results.
5) Use care when leaving the lab to place the dosimeter on the rack located in your lab so that dosimeters are not left in exposure areas such as an accelerator target room. If a dosimeter 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 a designated dosimeter rack in the laboratory for periodic exchange. Delay in returning a dosimeter results in considerable extra work and correspondence during follow up. A dosimeter which is returned late cannot be processed with the control dosimeter supplied with the shipment.
7) Do not remove the dosimeter from the facility.
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 is lost or damaged, a record of the incident will be made in order to document the period of time for which the exposure data was lost.

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

18.3 Records

18.3.1 Personnel Exposure Record

Personnel exposure data will be sent to each group or department to be available to dosimeter wearers when reports are received. Personnel exposure data shall be part of the permanent records of the EH&S Department. Upon written request by any wearer, EH&S will provide a copy of the individual's exposure history.

18.3.2 Records of Prior Exposure

Employees or students requiring personal dosimetry will be required to complete the appropriate form indicating all locations where previous radiation exposures may have occurred. 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, or termination of Authorized User status.

18.4 Internal Dosimetry

Bioassays may be required at the discretion of the RSO. As a general principle, bioassays will be required after any incident (e.g., contamination of personnel or exposure of persons to airborne radioactivity) where the possibility of internal deposition of radioisotopes exists. Bioassays include such tests as radioanalysis of blood, urine, fecal samples, nose swabs or 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 takes only a few minutes) or other bioassays may be arranged by calling the RSO at 784-4540.

18.4.1 Bioassay for Users of Radioiodine

Any person who works with forms of radioiodine where iodide ions or uncombined iodine might be present in quantities which equal or exceed the values in the table given below are required to have bioassays at intervals deemed appropriate by the RSO according to the Regulatory Guide 8.20 (Revision 2 dated September 2014).

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 which have been inspected and approved by the RSO.		
**Quantities in this table are cumulative amounts handled during a three month period.		

1. Anyone working with levels within the above limits will have a baseline bioassay performed within two weeks prior to beginning work with radioactive iodine.
2. 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.
3. Whenever an individual is found to have a thyroid burden in excess of 0.12 uCi of I-125 or 0.04 uCi of I-131, the RSO may take the following action:

    a. Complete a thorough evaluation of all aspects of the iodination procedure.

    b. Restrict the worker from further exposure until the source of exposure is discovered and corrected.

    c. Repeat the bioassay periodically to obtain an individual effective half-life and to determine committed effective dose equivalent.

    d. 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.

    e. Make reports of notifications as required by the State of Nevada Regulations.

Personnel are required to call the RSO whenever they suspect that they might have been exposed to airborne radioiodine or if they believe that they might have ingested or otherwise allowed radioiodine to enter their bodies.

18.5 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 EH&S.

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

18.5.1 Medical Records and Examination

1) It is the policy of the University of Nevada, Reno 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 included. Radiation workers shall be scheduled to appear at a prearranged time for the prescribed analysis.

3) Medical 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 medical examination records will be maintained in EH&S and coordinated with personnel dosimetry data.

18.6 Visitor Dosimetry

Visitors are not normally allowed in restricted areas. Prior arrangements have to be made between the RSO and the AU, if there is a need to have visitors in a restricted area. The RSO will arrange appropriate dosimetry as required.

19.0 PROCEDURE WHEN EXPOSURE LIMITS ARE EXCEEDED

19.1 Procedure When Administrative Limits are Exceeded

When UNR Administrative Exposure Limits (See Chapter 3) 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 an "Event Report" with EH&S describing any conditions or activities which may have led to the exposure.

2) The Radiation Safety Office:

- May change the dosimetry monitoring status to a more frequent interval if it is determined that the administrative limit was actually exceeded.
- Review the individual's radiation work procedures and determine the likelihood of the cause of exposure.
- Ensure that any unsafe practices are discontinued.

19.2 Regulatory Limits

The RSO or his/her designee must be notified IMMEDIATELY if any person is known to have, or suspected to have, received an over exposure. Such persons will be placed under proper care in order to determine the actual dose to the body and/or critical organ(s). Reports are provided, when appropriate, to regulatory authorities.

20.0 FACILITY DESIGN CRITERIA

20.1 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/hr and 50 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 as prescribed in Chapter 16.0 (Restricted Area Designation Procedure).

20.2 INTERLOCKS, WARNING DEVICES, and EMERGENCY SWITCHES

1. When conditions require installation of a radiation producing machine in a shielded enclosure, all access doors shall be equipped with interlocks due to the potential of the machine creating a High Radiation Area. These interlocks will shut the machine off if entry is attempted during the 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 is to 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.

20.3 POSTINGS

Each machine capable of producing ionizing radiation shall be labeled as follows:

"CAUTION – X-ray Device Produces Ionizing Radiation When Energized"
And Other Signs or Labels as Required

Standard signs can be obtained from EH&S. Additionally, the following information shall be posted on or near the machine where it may be readily observed.

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.

20.4 SPECIAL NOTES

1. Where an authorized user is in constant attendance during the temporary operation of a radiation producing machine, warning signals and barricades may be an acceptable substitute for shielding when approved by the RSO. The RSO's approval and a description of the devices and their use must be in writing and posted in the immediate vicinity of the machine(s).
2. When interlocks have been bypassed in order to facilitate experimentation, a survey of the radiation levels in the area(s) to be entered must be conducted. Bypassed safety systems and associated operational procedures must be PREAPPROVED IN WRITING by the RSO and only used under the specified conditions. When interlocks have been bypassed, the Authorized User must be in constant attendance during all procedures.
3. Electron microscopes and X-ray diffraction machines will be surveyed for safe operation before their first use, following any repairs, and annually.

20.5 Special Considerations for Certain Radiation Producing Machines Other Than Accelerators

20.5.1 Electron Microscopes

Normally these are low hazard devices. Operators need not wear personal dosimeters. The Radiation Safety staff will perform a radiation survey annually. 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.

20.5.2 X-ray Diffraction Machines

The primary beams from these devices may be as high as 400,000 R/Minute. The chief hazard is hand exposure to the hands 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 must be authorized by the RSO and are required to be trained in the safe use of x-ray diffraction devices. Users are required to wear both finger and whole body dosimetry when working in an open beam configuration. Annual surveys of each device will be made by Radiation Safety staff. Portable shielding is usually needed to reduce exposure levels from scattered radiation. Users may be required to have survey instruments present and to perform a radiation survey after a setup of the machine to ensure that shielding, collimators and beam stops are properly placed.

21.0 PHOSPHORUS-32 USE PROCEDURES

When opening P-32 stock vials that contain greater than 1mCi, the fume hood should be used. This is only required for the initial opening of P-32 stock vials upon receipt in your laboratory from the radioisotope vendors.

SOURCES GREATER THAN 10 mCi:

1. Low density shielding (e.g. Plexiglas) must be used in order to keep Bremsstrahlung radiation at a minimum.
2. After each use, mandatory radiation survey and wipe tests must be performed with the results recorded in the User Laboratory Log Book.
3. A finger type extremity badge must be worn by all users. (Request these from EH&S).
4. A dry run shall be performed prior to the performance of unfamiliar procedures in order to avoid unexpected complications. A dry run is required for each new individual performing a procedure that is new to that person.
5. Eye protection must be used for procedures that involve 10 millicuries or more.
6. Use remote handling tools when possible while handling stock solutions.
7. P-32 waste must be segregated to hold for decay.
8. P-32 waste must be shielded if the waste creates a radiation area.
9. The range that beta radiation travels on the average is about 7 feet with a maximum of 20 feet in the air.

22.0 NON-IONIZING RADIATION SOURCES

22.1 General

Certain devices such as lasers and microwave generators produce electromagnetic radiation with frequencies considerably lower than ionizing sources (x-rays, gamma rays) but which are still able to produce biological damage by mechanisms other than ionization. Such devices are subject to control in their use to ensure protection of individuals.

22.2 Specific Requirements

1. Any individual who purchases or otherwise obtains a laser for use at UNR is required to notify EH&S.
2. The operation of lasers is subject to certain federal control criteria. Any individual who intends to operate a laser at UNR is required to register it with EH&S. Refer to the UNR Laser Safety Manual for more laser safety requirements.
3. While no specific registration procedure is required for microwave sources, any device which is expected to produce, or suspected of producing possibly hazardous levels of microwave radiation should be brought to the attention of the RSO so that a proper review/survey of the device may be made.
4. Any other known or suspected sources of possibly hazardous nonionizing radiations should be reported to EH&S.

APPENDIX A

RADIATION SAFETY OFFICE STAFF AND SERVICES

I. Staff (Nominal)

Radiation Safety Officer
Radiation Safety Technician
Radiation Safety Administrative Assistant/Clerk

II. Services

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

A. PERSONNEL MONITORING

Appropriate personnel monitoring devices such as film badges, thermoluminescent dosimeters and/or pocket dosimeters will be assigned to each person who is likely to exceed 10% of annual external occupation 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/or 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.

C. RADIATION INSTRUMENT CALIBRATION

The Radiation Safety Office is responsible for ensuring that all radiation 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. No waste shall be disposed of without written permission from the Radiation Safety Officer. Waste will be stored according to its classification.

1. Dry Waste shall be stored in closed containers lined with a heavy, transparent plastic bag.

2. Liquid waste shall be stored in closed, leak-tight metal or plastic containers. The container must be placed in a secondary container large enough to hold all the contents of the primary container that may leak. With tritium, glass containers may be used with authorization from the RSO.

3. 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.

4. Waste which 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.

5. Non-radioactive waste must not be placed in radioactive waste storage containers.

6. 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.

7. The Authorized User is responsible for making entries into his/her radioisotope inventory records of such transfers.

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.

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. Appropriate labels will be affixed to the package. Transportation or delivery of radioactive materials must be in accordance with provisions of 49 CFR.

G. EMERGENCY ASSISTANCE

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 EH&S telephone at **327-5040**. A copy of all emergency procedures and the list of emergency telephone numbers will be provided to all Authorized Users.

H. RADIATION SAFETY TRAINING

The Radiation Safety Office will provide formal and/or informal training to all persons prior to their working with or around radiation sources. This will include the specific requirements set forth in this manual and general radiation protection techniques required for work involving radiation sources.

APPENDIX B

RADIATION LABORATORY 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 radioisotope and before doing other work.
3.	**Pipetting:**	Pipetting by mouth is prohibited
4.	**Protective Clothing:**	Always use protective laboratory gloves when handling radioisotope. 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 trays or work surfaces lined with an absorbent material. Keep, and transport, radioisotopes doubly contained.
6.	**Labeling:**	Label radioisotope 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. Remove any contamination found and monitor the area to ensure successful decontamination.
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 regular waste. Waste log shall be kept on the waste container or nearby.
9	**Counting Room:**	Take only prepared samples into the counting room. No potentially contaminated material or apparatus is permitted in the counting room or area.
10	**Hoods:**	Materials which could become airborne must be stored and used in an approved hood or glove box.
11	**Security:**	Secure all radioactive materials when the 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 without authorization from the Radiation Safety Office.
14	**Exposure:**	No one shall cause any person unnecessary exposure to radiation.

LABORATORY SPILLS

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

In the event of accidental spillage, keep calm, use common sense, protect people, and do not spread the contamination. If there are high radiation levels or 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 of the spill or contaminated items or surfaces shall be avoided. Use the following as guides:

1. Notify persons in the area that a spill has occurred
2. Localize the spill. Put on disposable gloves, right the container, and blot the spill with absorbent material. Do not wipe or use wiping motions because this may spread the contamination.
3. Water and mild soap may be used if necessary.
4. Survey the area with appropriate instruments. Check the area around the spill, your hands, clothing and shoes for contamination.
5. Report the incident to the Radiation Safety Office.

APPENDIX C

WASTE PICK-UP AND DISPOSAL PROCEDURES

DISPOSAL OF RADIATION SOURCES

All radiation sources must be disposed of in accordance with procedures established by the RSO. The users shall contact the RSO by email, telephone, or waste pick-up request by internet for disposal of radiation sources. The RSO shall provide instructions for storage of small quantities of waste in user laboratories and shall arrange for pick-up of such materials.

DISPOSAL OF RADIOACTIVE WASTE BY THE EH&S

Radioactive waste can be disposed of only by the EH&S or in a manner which has been specifically approved by the RSO. All packaging for final disposal will be accomplished by EH&S at sites reserved for this purpose.

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

A. Label all waste "CAUTION -- RADIOACTIVE MATERIAL", with the legal symbol, and record the following information on the log sheet provided with each container.

Name of Authorized User
Identify isotope
Amount of isotope in millicuries
Date material is placed in container
Identify any presence of any other hazardous materials

B. All solid, absorbed liquid, scintillation vials and/or animal carcasses must be packaged in the manner outlined as follows:

1. PACKAGING OF DRY SOLID RADIOACTIVE WASTE (paper towels, hand gloves, syringes, empty bottles, clothing, etc.):

   a. 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 RSO before disposal.
   b. No labels are to be put into the waste barrel such as radioactive labels, biohazard labels, or any type of warning label.
   c. The container must be lined with a plastic liner.
   d. 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 container prior to disposal.
   e. Separate long ($T_{1/2}$ > 15 days) and short lived RAM waste.
   f. Put only contaminated articles in the RAM waste barrel.

g. Log all entries on the waste log.

2. PACKAGING OF LIQUID SCINTILLATION VIALS

Organic solvents are not allowed to be mixed with radioactive material. Biodegradable non-hazardous liquid scintillation solutions are allowed in UNR.

a. Container must be approved by the RSO.
b. Container must be lined with a plastic liner and sealed at the top when container is packed.
c. The vials are not to be opened and should be checked for loose caps prior to being deposited in the waste barrel.
d. Do not dispose of non-radioactive vials in the waste barrel.
e. Log all entries on the waste log.

3. 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 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.
10. Use only absorbents approved by EH&S.

UNUSUAL RADIOACTIVE WASTE DISPOSAL PROBLEMS

Cases where radioactive waste cannot be disposed of as outlined above must be referred to EH&S.

APPENDIX D

EMERGENCY PROCEDURES

Introduction

Any medical emergency should take priority over radiological emergency. Radioactive materials used in research at UNR cannot produce life threatening levels of radiation under any circumstances.

The objectives for handling radiological emergencies are to assist injured personnel, minimize the radioactive material entering into human body, prevent the spread of contamination, and remove the contamination as soon as possible. When approaching radiological emergencies, it is recommended to apply these objectives 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 EH&S as soon as practical with the exception of easily cleaned minor contamination. All incidents must be documented. This documentation must include the final survey indicating that all contamination has been removed.

Personnel decontamination

Contaminated areas of the body need to be identified using appropriate survey methods. Do not use any decontamination methods which may spread material, increase penetration into the body, or spread to wounded area, if any.

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, by applying gentle scrubbing. Avoid harsh scrubbing which may increase skin penetration. If contamination persists, stronger decontamination methods may be necessary after first consulting with the EH&S.

Decontamination of minor spills

Most incidents will involve small amounts (microcurie level) of radioactivity which are considered to be a minor spill or contamination. 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. Warn others in the lab that a contamination occurred.
2. Fresh new gloves should be worn to protect hands and avoid spread of contamination.
3. Use paper towels or absorbent paper to prevent spread.
4. Mark off the contaminated area.
5. Do not allow lab personnel to leave the area without first being monitored.
6. Secure all contaminated items in sealed containers to prevent spread of contamination

Major spills

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

1. Upright the leaking container or cut off the release of radioactivity from the source if possible.
2. Minimize radiation exposure to personnel.
3. Minimize contamination from spreading.
4. If airborne radioactivity is possible, turn off hood, and close windows, shut off ventilation if possible.
5. Secure all contaminated items to prevent spread of contamination.
6. Secure the contaminated area.
7. Report incident to EH&S.
8. Remain in the general area until EH&S personnel arrive.

APPENDIX E

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).

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.

AIRBORNE RADIOACTIVITY AREA 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**:** An application which 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 CUA).

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): A Unit of radioactivity equal to one radioactive disintegration per second.

***BIOASSAY* (radiobioassay)** means the determination of kinds, quantities or 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 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 ($H_{E.50} = \Sigma w_T H_{T.50}$).

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**:** The basic unit of radioactivity is the Curie (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:

millicurie (mCi) = 3.7E7 dps
microcurie (uCi) = 3.7E4 dps
picocurie (pCi) = 3.7E-2 dps

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

DEPARTMENT means the Department of Energy established by the Department of Energy Organization Act (Pub. L. 95-91, 91 Stat. 565, 42 U.S.C.7101 et seq.) to the extent that the Department, or its duly authorized representatives, exercises functions formerly vested in the U.S, Atomic Energy Commission, its Chairman, members, officers, and components and transferred to the U.S. Energy Research and Development Administration and to the Administrator thereof pursuant to sections 104 (b), (c), and (d) of the Energy Reorganization Act of 1974 (Pub. L. 93-438, 88 Stat. 1233 at 1237, 42 U.S.C. 5814) and retransferred to the Secretary of Energy pursuant to section 301 (a) of the Department of Energy Organization Act (Pub. L. 95-91, 91 Stat 565 at 577-578, 42 U.S.C, 7151).

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 "20.1001-20.2401.

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 -- the equipment. ($H_{E.50} = \Sigma W_T H_{T.50}$).

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 ($H_E = \Sigma w_T H_T$).

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 or to radioactive material.

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/cm^2).

GENERALLY APPLICABLE ENVIRONMENTAL RADIATION STANDARDS means standards issued by the Environmental Protection Agency (EPA) under the authority of the Atomic Energy Act of 1954, as amended that 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 licensed issued by the division pursuant to this chapter.

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 a controlled 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 which contains regulations and

requirements pertaining to the University license.

NONSTOCHASTIC EFFECT means health effects, 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 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**:** Devices which 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.

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 which 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 which 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.

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*:** 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 SV=100 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 means - (1) plutonium, uranium-233, uranium enriched in the isotope 233 or in the isotope 235, and any other material that the Commission, pursuant to the provisions of section 51 of the Act, determines to be special nuclear material, but does not include source material; or (2) Any material artificially enriched by any of the foregoing but does not include source material.

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.

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 500 rads (5 grays) 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.

WEIGHING 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 WEIGHING FACTORS		
Organ or tissue		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]

[1]0.30 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 Weighing the external whole body dose (for adding it to the internal dose), a single weighing factor w_T=1.0, has been specified. The use of other weighing 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 $1.3x10^5$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.

Notices; Instructions and Reports to Employees; Inspections

NAC 459.780 Purpose; applicability. (NRS 459.201) NAC 459.780 to 459.794, inclusive:

1. Establish requirements for notices, instructions and reports by licensees or registrants to persons engaged in work under a license or registration and options available to those persons in connection with the Division's inspections of licensees or registrants to ascertain compliance with the provisions of chapter 459 of NRS and regulations, orders and licenses issued thereunder regarding radiological working conditions.

2. Apply to all persons who receive, possess, use or transfer sources of radiation licensed by or registered with the Division pursuant to NAC 459.150 to 459.313, inclusive.

[Bd. of Health, Radiation Control Reg. § 10.1, eff. 2-28-80]—(NAC A by R149-07, 1-30-2008)

NAC 459.782 Notices to employees. (NRS 459.201)

1. Each licensee or registrant shall post current copies of the following documents:

(a) The provisions of NAC 459.320 to 459.374, inclusive, and 459.780 to 459.794, inclusive;

(b) The license, certificate of registration, conditions or documents incorporated into the license by reference and amendments thereto;

(c) The operating procedures applicable to work under the license or registration; and

(d) Any notice of a violation involving radiological working conditions, any proposed imposition of a civil penalty or an order issued pursuant to NAC 459.010 to 459.142, inclusive, and any response from the licensee or registrant.

2. If posting of a document specified in paragraphs (a) to (c), inclusive, of subsection 1 is not practicable, the licensee or registrant shall post a notice which describes the document and states where it may be examined.

3. Form NRC-1, "Notice to Employees," must be posted by each licensee or registrant.

4. Any notices, forms or other documents posted must appear in a sufficient number of places to permit persons engaged in work under the license or registration to observe them on the way to or from any particular work location to which the document applies. The documents must be conspicuous and must be replaced if defaced or altered.

5. Documents to be posted pursuant to paragraph (d) of subsection 1 must be posted within 5 working days after receipt of the documents from the Division. The licensee's or registrant's response, if any, must be posted within 5 working days after dispatch from the licensee or registrant. These documents must remain posted for a minimum of 5 working days or until action correcting the violation has been completed, whichever is later.

[Bd. of Health, Radiation Control Reg. §§ 10.2-10.2.5, eff. 2-28-80]—(NAC A 1-18-94)

NAC 459.784 Instructions to employees. (NRS 459.201)

1. All persons who in the course of employment are likely to receive in 1 year an occupational dose of more than 100 millirems must:

(a) Be informed of the storage, transfer or use of radioactive material or of radiation;

(b) Be instructed in the problems of health protection associated with exposure to such radioactive material or radiation;

(c) Be instructed in precautions or procedures to minimize exposure and in the purposes and functions of the protective devices which are provided;

(d) Be instructed in and required to comply with the provisions of NAC 459.010 to 459.794, inclusive, and licenses which pertain to the protection of personnel from any exposures to

radiation or radioactive materials;

(e) Be informed of their responsibility to report promptly to the licensee or registrant any condition which may cause or lead to a violation of NAC 459.010 to 459.794, inclusive, or licenses or any unnecessary exposure to radiation or radioactive material;

(f) Be instructed in the appropriate response to warnings made in the event of any unusual occurrence or malfunction that may involve exposure to radiation or radioactive material; and

(g) Be advised of the existence of exposure reports to radiation which workers may request pursuant to NAC 459.786.

2. In determining which persons are subject to the requirements of this section, licensees shall consider:

(a) The assigned activities of the person during normal and abnormal situations involving exposure to radiation or radioactive material that can reasonably be expected to occur during the life of the licensed facility; and

(b) The potential problems relating to the protection against radiation and radioactive material present in the licensed facility.

[Bd. of Health, Radiation Control Reg. §§ 10.3-10.3.8, eff. 2-28-80]—(NAC A by R084-98, 1-26-99)

NAC 459.786 Reporting of certain information. (NRS 459.070, 459.201)

1. Data concerning a person's exposure to radiation and the results of any measurements, analyses and calculations of radioactive material deposited or retained in the body of a person must be reported to him or her, as specified in this section. The information reported must include data and results obtained pursuant to NAC 459.010 to 459.794, inclusive, orders or conditions set forth in the license or registration, as shown in records maintained by the licensee or registrant pursuant to those sections. Each notification and report must:

(a) Be in writing;

(b) Include the name of the registrant or licensee, the name of the person and his or her social security number;

(c) Include the information relating to the person's exposure; and

(d) Contain the following statement:

This report is furnished to you pursuant to NAC 459.780 to 459.794, inclusive, adopted by the State Board of Health. You should preserve this report for further reference.

2. Each licensee and registrant shall advise each of its workers annually of their exposure to radiation or radioactive material as shown in records maintained by the licensee or registrant pursuant to NAC 459.3665. An annual report of the exposure in that monitoring year must be provided to each person monitored pursuant to NAC 459.339 if:

(a) The person's occupational dose exceeds 1 mSv (100 mrem) total effective dose equivalent or 1 mSv (100 mrem) to any individual organ or tissue; or

(b) The person requests his or her annual dose report.

3. At the request of a worker formerly engaged in work controlled by the licensee or the registrant, the licensee or registrant shall furnish to the worker a report of his or her exposure to radiation or radioactive material. The report must be furnished within 30 days after the time the request is made or within 30 days after his or her exposure has been determined, whichever is later. The report must cover, within the period specified in the request, each calendar quarter in which the worker's activities involved exposure to radiation from radioactive material licensed

by or radiation machines registered with the Division and must include the dates and locations of work under the license or registration in which the worker participated during this period.

4. When a licensee or registrant is required pursuant to NAC 459.3695, 459.371 or 459.3715 to report to the Division any exposure of a person to radiation or radioactive material, the licensee or registrant shall also provide the person with a report on his or her exposure data. The report to the person must be transmitted to the person before transmittal of the report to the Division.

5. At the request of a worker who is terminating employment with a licensee or registrant in work involving exposure to radiation in a calendar quarter or of a worker who, while employed by another person, is terminating an assignment to work involving exposure to radiation in the licensee's or registrant's facility in a calendar quarter, the licensee or registrant shall provide the worker at the time of the termination a written report specifying the dose of radiation which he or she received from the operations of the licensee or registrant during the calendar quarter or fraction thereof or shall provide him or her a written estimate of that dose if the results of personnel monitoring have not been finally determined and are not available at that time. An estimated dose must be clearly indicated as such.

[Bd. of Health, Radiation Control Reg. §§ 10.4-10.4.5, eff. 2-28-80]—(NAC A 1-18-94; R185-08, 5-7-2010)

NAC 459.788 Inspections: Generally; presence of representatives of licensees, registrants and employees. (NRS 459.201)

1. Each licensee or registrant shall permit the Division, at all reasonable times, an opportunity to inspect materials, machines, activities, facilities, premises and records pursuant to NAC 459.010 to 459.794, inclusive.

2. During an inspection, division inspectors may consult privately with workers, as specified in NAC 459.790. The licensee or registrant may accompany the Division's inspectors during other phases of an inspection.

3. If, at the time of an inspection, a person has been authorized by the workers to represent them during the inspection, the licensee or registrant must notify the inspectors of the authorization and give the workers' representative an opportunity to accompany the inspectors during the inspection of physical working conditions.

4. Each workers' representative must be routinely engaged in work under control of the licensee or registrant and must have received instructions as specified in NAC 459.784.

5. Different representatives of licensees or registrants and workers may accompany the inspectors during different phases of an inspection if there is no resulting interference with the conduct of the inspection, but only one workers' representative at a time may accompany the inspectors.

6. With the approval of the licensee or registrant and the workers' representative, a person who is not routinely engaged in work under control of the licensee or registrant, for example, a consultant to the licensee or registrant or to the workers' representative, may be afforded the opportunity to accompany division inspectors during the inspection of physical working conditions.

7. Notwithstanding the other provisions of this section, division inspectors may refuse to permit accompaniment by any person who deliberately interferes with a fair and orderly inspection. With regard to any area containing proprietary information, the workers' representative for that area must be a person previously authorized by the licensee or registrant to enter that area.

[Bd. of Health, Radiation Control Reg. §§ 10.5-10.5.7, eff. 2-28-80]

NAC 459.790 Inspections: Consultation with employees. (NRS 459.201)

1. The inspectors of the Division may consult privately with workers on matters related to their protection from occupational radiation and matters related to applicable provisions of NAC 459.010 to 459.794, inclusive, to the extent that the inspectors deem necessary for the conduct of an effective and thorough inspection.

2. During the course of an inspection, any worker may bring privately to the attention of the inspectors, either orally or in writing, any past or present condition which the worker has reason to believe may have contributed to or caused any violation of chapter 459 of NRS, NAC 459.010 to 459.794, inclusive, or license condition, or any unnecessary exposure of a person to radiation from licensed radioactive material or a registered radiation machine under the licensee's or registrant's control. Any such notice in writing must comply with the requirements of subsection 1 of NAC 459.792.

3. Subsection 2 is not an authorization to disregard instructions in NAC 459.784.

[Bd. of Health, Radiation Control Reg. §§ 10.6-10.6.3, eff. 2-28-80]

NAC 459.792 Inspections: Requests by employees. (NRS 459.201)

1. Any worker or representative of workers who believes that a violation of chapter 459 of NRS, NAC 459.010 to 459.794, inclusive, or license conditions exists or has occurred in work under a license or a registration with regard to radiological working conditions in which the worker is engaged, may request an inspection by giving notice of the alleged violation to the Division. Any such notice must be in writing, set forth the specific grounds for the notice, and must be signed by the worker or representative of the workers. A copy must be given to the licensee or registrant by the Division no later than at the time of inspection except that, upon the request of the worker giving the notice, his or her name and the name of the persons referred to therein must not be disclosed in any copy or on any record published, released or made available by the Division, except for good cause shown.

2. If, upon receipt of the notice, the Division determines that the complaint meets the requirements in subsection 1, and that there is a reasonable ground to believe that the alleged violation exists or has occurred, the Division shall cause an inspection to be made as soon as practicable, to determine whether the alleged violation exists or has occurred. Inspections pursuant to this section need not be limited to matters referred to in the complaint.

3. No licensee or registrant may discharge or in any manner discriminate against any worker because the worker has filed any complaint, instituted or caused to be instituted any proceeding under NAC 459.010 to 459.794, inclusive, or has testified or is about to testify in any such proceeding or because the worker, on behalf of himself or herself or others, has exercised any option afforded by NAC 459.780 to 459.794, inclusive.

[Bd. of Health, Radiation Control Reg. §§ 10.7-10.7.3, eff. 2-28-80]

NAC 459.794 Inspections: Informal review. (NRS 459.201)

1. If the Division determines, with respect to the complaint under NAC 459.792, that an inspection is not warranted because there are no reasonable grounds to believe that a violation exists or has occurred, the Division must notify the complainant in writing of that determination.

2. The complainant may obtain a review of the determination by submitting a written statement of his or her position with the Chief Medical Officer, who shall provide the licensee or registrant with a copy of the statement by certified mail, excluding, at the request of the complainant, the name of the complainant. The licensee or registrant may submit an opposing written statement of position with the Chief Medical Officer, who shall provide the complainant

with a copy of the statement by certified mail. Upon request of the complainant, the Chief Medical Officer may hold an informal conference, pursuant to subsection 2 of NAC 459.136, in which the complainant and licensee or registrant, may orally present their views. An informal conference may also be held at the request of the licensee or registrant, but disclosure of the identity of the complainant may be made only following receipt of his or her written authorization. After considering all written or oral views presented, the Chief Medical Officer shall affirm, modify or reverse the determination of the Division and furnish the complainant and the licensee or registrant a written notification of the decision and the reason therefore.

3. The informal conference cannot be appealed and is the final remedy available to the complainant or the licensee or registrant pursuant to subsection 3 of NAC 459.136.

4. If the Division determines that an inspection is not warranted because the requirements of subsection 1 of NAC 459.792 have not been met, the Division shall notify the complainant in writing of that determination. Such a determination is without prejudice to the filing of a new complaint meeting the requirements of that subsection.

[Bd. of Health, Radiation Control Reg. §§ 10.8-10.8.4, eff. 2-28-80]—(NAC A 10-30-97)

Standards for Protection Against Radiation

NAC 459.320 Purpose; applicability; reasonable effort required. (NRS 459.030, 459.201)

1. The provisions of NAC 459.320 to 459.374, inclusive, establish standards for protection against radiation hazards. It is the purpose of those sections to control the receipt, possession, use, disposal and transfer of licensed or registered sources of radiation by any licensee or registrant in such a manner that the total dose to a natural person, including exposures to licensed or unlicensed or registered or unregistered sources of radiation, whether in the possession of the licensee, registrant or any other person, but not including exposure to radiation from natural background sources, medical diagnosis and therapy, natural persons who have been administered radioactive drugs or have received permanent implants containing radioactive material and have been released from the control of a licensee pursuant to 10 C.F.R. § 35.75, or voluntary participation in medical research does not exceed the standards of radiation protection set forth in NAC 459.320 to 459.374, inclusive. Those sections will not be construed as limiting actions that may be necessary to protect the health and safety of the public.

2. Except as otherwise specifically provided, NAC 459.320 to 459.374, inclusive, apply to all licensees or registrants. Those sections do not limit the intentional exposure of natural persons to radiation for the purpose of medical use or the intentional exposure of natural persons to radiation who are voluntarily participating in programs for medical research.

3. In addition to complying with the requirements set forth in NAC 459.320 to 459.374, inclusive, a licensee or registrant shall make every reasonable effort to maintain exposures and releases of radioactive materials in effluents to unrestricted areas, as low as is reasonably achievable.

[Bd. of Health, Radiation Control Reg. §§ 4.1-4.1.2, eff. 2-28-80]—(NAC A 1-18-94; R084-98, 1-26-99; A by Dep't of Human Resources by R137-01, 5-30-2003; A by Bd. of Health by R085-06, 11-13-2006)

NAC 459.3205 Adoption by reference of certain provisions of federal regulations. (NRS 459.201) The State Board of Health hereby adopts by reference appendices A, B and C to 10 C.F.R. §§ 20.1001 to 20.2402, inclusive, as those provisions existed on October 13, 1999. A copy of the volume containing these appendices may be purchased by mail from the Superintendent of Documents, U.S. Government Printing Office, P.O. Box 979050, St. Louis, Missouri 63197-9000, or by toll-free telephone at (866) 512-1800, for the price of $39, or are available, free of charge, at the Internet address **http://www.gpoaccess.gov/cfr/index.html**.

(Added to NAC by Bd. of Health, eff. 1-18-94; A by R084-98, 1-26-99; R085-06, 11-13-2006)

NAC 459.321 Development, implementation and review of program for protection against radiation; establishment of constraint on air emissions to environment of radioactive material. (NRS 459.030, 459.201)

1. Each licensee and registrant shall:

(a) Develop, document and carry out a program for protection against radiation commensurate with the scope of its licensed or registered activities and sufficient to ensure compliance with the provisions of NAC 459.010 to 459.950, inclusive.

(b) Use, to the extent practicable, procedures and engineering controls, based upon sound principles of protection against radiation, to achieve occupational doses and doses to members of the public that are as low as is reasonably achievable.

(c) Review, at intervals not to exceed 12 months, the content and implementation of the program for protection against radiation.

2. A licensee or registrant shall, to achieve doses to members of the public that are as low as is reasonably achievable pursuant to paragraph (b) of subsection 1, establish a constraint on air emissions to the environment of radioactive material, excluding radon 222 and its decay products, such that the individual member of the public likely to receive the highest dose from such emissions will not be expected to receive a total effective dose equivalent in excess of 10 millirems (0.1 millisievert).

3. A licensee or registrant that causes, permits or is otherwise responsible for air emissions of radioactive material to the environment that exceed the constraint established pursuant to subsection 2 shall:

(a) Submit to the Division the report required by NAC 459.371; and

(b) Promptly take appropriate corrective action to prevent any recurrence.

(Added to NAC by Bd. of Health, eff. 1-18-94; A by R084-98, 1-26-99; A by Dep't of Human Resources by R137-01, 5-30-2003; A by Bd. of Health by R149-07, 1-30-2008)

NAC 459.323 Weighting factors. (NRS 459.201)

1. For calculating the effective dose equivalent, the values of the weighting factor are as follows:

Organ Dose Weighting Factors

Organ or Tissue	Weighting Factor
Gonads	0.25
Breast	0.15
Red bone marrow	0.12
Lung	0.12
Thyroid	0.03
Bone surfaces	0.03
Remainder	0.30
Whole Body	1.00

2. For the purposes of weighting the remainder dose, 0.30 results from 0.06 of each of five remainder organs, excluding the skin and the lens of the eye, that receive the highest doses.

3. The use of other weighting factors for external exposure must first be approved by the Division.

(Added to NAC by Bd. of Health, eff. 1-18-94)

NAC 459.3235 Quality factors for converting absorbed dose to dose equivalent. (NRS 459.201)

1. Except as otherwise provided in subsection 2, the quality factors for converting an absorbed dose to a dose equivalent are as follows:

Quality Factors and Absorbed Dose Equivalencies

Type of Radiation	Quality Factor	Absorbed Dose Equal to a Unit Dose Equivalent
X, gamma, or beta radiation and high-speed electrons……	1	1
Alpha particles, multiple-charged particles, fission fragments and heavy particles of unknown charge.....	20	0.05
Neutrons of unknown energy.....	10	0.1
High-energy protons.....	10	0.1

2. If it is more convenient to measure the neutron fluence rate than to determine the neutron dose equivalent rate in rems per hour, as provided in subsection 1, 1 rem of neutron radiation of unknown energies may, for the purposes of NAC 459.010 to 459.950, inclusive, be assumed to result from a total fluence of 25,000,000 neutrons per square centimeter incident upon the body. If sufficient information exists to estimate the approximate energy distribution of the neutrons, the licensee or registrant may use the fluence rate per unit dose equivalent or the appropriate quality factor value from the following table to convert a measured tissue dose in rads to dose equivalent in rem:

Mean Quality Factors and Fluence per Unit Dose Equivalent for Monoenergetic Neutrons

	Neutron Energy (MeV)	Quality Factor	Fluence per Unit Dose Equivalent (neutrons cm^2 rem^{-1})
(thermal)	2.5E-8	2	980E+6
	1E-7	2	980E+6
	1E-6	2	810E+6
	1E-5	2	810E+6
	1E-4	2	840E+6
	1E-3	2	980E+6
	1E-2	2.5	1010E+6
	1E-1	7.5	170E+6
	5E-1	11	39E+6
	1	11	27E+6

Mean Quality Factors and Fluence per Unit Dose Equivalent for Monoenergetic Neutrons

Neutron Energy	Quality Factor	Fluence per Unit Dose Equivalent
2.5	9	29E+6
5	8	23E+6
7	7	24E+6
10	6.5	24E+6
14	7.5	17E+6
20	8	16E+6
40	7	14E+6
60	5.5	16E+6
1E+2	4	20E+6
2E+2	3.5	19E+6
3E+2	3.5	16E+6
4E+2	3.5	14E+6

3. For the purposes of subsection 2, the quality factor must be measured at the point where the dose equivalent is maximum in a 30-centimeter diameter cylinder tissue-equivalent phantom.

(Added to NAC by Bd. of Health, eff. 1-18-94; A by R084-98, 1-26-99; R085-06, 11-13-2006; R149-07, 1-30-2008)

NAC 459.325 Limits on occupational doses for adults. (NRS 459.030, 459.201)

1. Except as otherwise provided in subsection 5, a licensee or registrant shall control occupational doses, except for planned special exposures, to ensure that no adult receives annually occupational doses in excess of the following limits:

(a) The lesser of:

(1) A total effective dose equivalent of 5 rems (50 millisieverts); or

(2) The sum of the deep-dose equivalent and the committed dose equivalent to any individual organ or tissue, other than the lens of the eye, of 50 rems (500 millisieverts);

(b) A lens dose equivalent of 15 rems (150 millisieverts); and

(c) A shallow-dose equivalent to the skin of the whole body or the skin of any extremity of 50 rems (500 millisieverts).

2. Occupational doses received in excess of the annual limits specified in subsection 1, including doses received during accidents, emergencies and planned special exposures, must be subtracted from the limits for planned special exposures that a person may receive during a current year and during his or her lifetime.

3. When the external exposure is determined by a measurement with an external personal monitoring device, the deep-dose equivalent must be used in lieu of the effective dose equivalent, unless the effective dose equivalent is determined by a dosimetry method approved by the Division. The assigned deep-dose equivalent must be for the portion of the body receiving the highest exposure. The assigned shallow-dose equivalent must be the dose averaged over the contiguous 10 square centimeters of skin receiving the highest exposure. The deep-dose equivalent, lens dose equivalent and shallow-dose equivalent may be assessed from surveys or other radiation measurements for the purpose of demonstrating compliance with the limits for

occupational doses, if the personnel monitoring equipment was not in the region of highest potential exposure, or the results of personnel monitoring are unavailable.

4. The derived air concentration and annual limit on intake values that are set forth in table I of appendix B may be used to determine the occupational dose of a person and to demonstrate compliance with the limits for occupational doses.

5. Notwithstanding the annual limits, a licensee shall limit a person's intake of soluble uranium to 10 milligrams in 1 week.

6. The licensee or registrant shall reduce the occupational dose that a person is allowed to receive in a current year by the amount of the occupational dose that person received during the year while employed by another person.

(Added to NAC by Bd. of Health, eff. 1-18-94; A by Dep't of Human Resources by R137-01, 5-30-2003; A by Bd. of Health by R085-06, 11-13-2006; R185-08, 5-7-2010)

NAC 459.3255 Compliance with requirements for summation of external and internal doses. (NRS 459.030, 459.201)

1. If a licensee is required to monitor a person pursuant to subsections 1 and 2 of NAC 459.339, the licensee shall demonstrate compliance with the limits set forth in NAC 459.325 by adding external and internal doses. The licensee may demonstrate compliance with the requirements for summation of external and internal doses by meeting one of the conditions specified in subsection 2 and the conditions specified in subsections 3 and 4. The lens dose equivalent and the dose equivalents for the skin and the extremities are not required to be included in the summation, but are subject to separate limits set forth in NAC 459.325. If a licensee or registrant is required to monitor a person pursuant to subsection 1 of NAC 459.339 only or pursuant to subsection 2 of NAC 459.339 only, the summation of the doses is not required.

2. If the only intake of radionuclides is by inhalation, the limit for the total effective dose equivalent is not exceeded if the deep-dose equivalent divided by the limit for the total effective dose equivalent, and one of the following, does not exceed unity:

(a) The sum of the fractions of the annual limit on intake by inhalation for each radionuclide.

(b) The total number of derived air concentration-hours for all radionuclides, divided by 2,000.

(c) The sum of the committed effective dose equivalents to all significantly irradiated organs or tissues, calculated from bioassay data using appropriate biological models and expressed as a fraction of the annual limit. For the purposes of this subsection, an organ or tissue shall be deemed to be irradiated significantly if, for that organ or tissue, the product of the weighting factors and the committed dose equivalent, per unit intake, is greater than 10 percent of the maximum weighted value of the committed dose equivalent, per unit intake for any organ or tissue.

3. If a person who receives an occupational exposure also receives an intake of radionuclides by oral ingestion in an amount greater than 10 percent of the applicable annual limit on intake by oral ingestion, the licensee shall account for this intake and include it in demonstrating compliance with the limits set forth in NAC 459.325.

4. Except as otherwise provided in this subsection, the licensee shall evaluate and, to the extent practical, account for the intake of radiation through wounds or absorption through the skin. Any intake through intact skin is not required to be evaluated or accounted for pursuant to this subsection.

(Added to NAC by Bd. of Health, eff. 1-18-94; A by Dep't of Human Resources by R137-01,

5-30-2003)

NAC 459.327 Determination of external dose from airborne radioactive material. (NRS 459.030, 459.201)

1. Licensees shall, when determining the external dose from airborne radioactive material, include the deep-dose equivalent, lens dose equivalent and shallow-dose equivalent caused by external exposure to the cloud of airborne radioactive material.

2. Measurements of airborne radioactive material and derived air concentration must not be used as the primary means to assess the deep-dose equivalent if the airborne radioactive material includes radionuclides other than noble gases or if the cloud of airborne radioactive material is not relatively uniform. The determination of the deep-dose equivalent must be based upon measurements using instruments or personnel monitoring equipment.

(Added to NAC by Bd. of Health, eff. 1-18-94; A by Dep't of Human Resources by R137-01, 5-30-2003)

NAC 459.3275 Determination of compliance with limits for occupational doses. (NRS 459.201)

1. For the purposes of assessing the dose used to determine compliance with the limits for occupational doses set forth in NAC 459.325, a licensee shall, if required pursuant to subsection 2 of NAC 459.339, take suitable and timely measurements of:

(a) Concentrations of radioactive materials in the air in work areas;

(b) Quantities of radionuclides in the body;

(c) Quantities of radionuclides excreted from the body; or

(d) Any combination of the measurements listed in paragraphs (a), (b) and (c).

2. Unless a respiratory protective device is used or the assessment of intake is based on bioassays, the licensee shall assume that a person inhales radioactive material at the airborne concentration in which the person is present.

3. When specific information on the physical and biochemical properties of the radionuclides taken into the body or the behavior of the material in a person is known, the licensee may:

(a) Use that information to calculate the committed effective dose equivalent;

(b) Upon prior approval of the Division, adjust the values for the derived air concentration or the annual limit on intake to reflect the actual physical and chemical characteristics of airborne radioactive material; and

(c) Separately assess the contribution of fractional intakes of compounds of a given radionuclide in Class D, W or Y to the committed effective dose equivalent.

Ê If a licensee uses the information to calculate the committed effective dose equivalent pursuant to paragraph (a), the licensee shall document that information in the record of the person.

4. If the licensee chooses to assess intakes of material in Class Y using the measurements taken pursuant to paragraph (b) or (c) of subsection 1, the licensee may delay the recording and reporting of the assessments for not more than 7 months in order to make additional measurements basic to the assessments, unless he or she is otherwise required to record and report the assessments by NAC 459.3695 or 459.371.

5. If the identity and concentration of each radionuclide in a mixture are known, the fraction of the derived air concentration applicable to the mixture that is used to calculate derived air concentration-hours must be:

(a) The sum of the ratios of the concentration to the appropriate value for the derived air concentration from Appendix B for each radionuclide in the mixture; or

(b) The ratio of the total concentration for all radionuclides in the mixture to the most restrictive value for the derived air concentration for any radionuclide in the mixture.

6. If the identity of each radionuclide in a mixture is known, but the concentration of one or more of the radionuclides in the mixture is not known, the derived air concentration for the mixture must be the most restrictive derived air concentration of any radionuclide in the mixture.

7. If a mixture of radionuclides in air exists, a licensee may disregard certain radionuclides in the mixture if:

(a) The licensee uses the total activity of the mixture in demonstrating compliance with the limits specified in NAC 459.325 and in complying with the monitoring requirements specified in subsection 2 of NAC 459.339;

(b) The concentration of any radionuclide disregarded is less than 10 percent of its derived air concentration; and

(c) The sum of these percentages for all of the radionuclides disregarded in the mixture does not exceed 30 percent.

8. When determining the committed effective dose equivalent, the following information may be considered:

(a) The licensee or registrant may assume that the inhalation of one annual limit on intake, or an exposure of 2,000 derived air concentration-hours, results in a committed effective dose equivalent of 5 rems for radionuclides that have their annual limits on intake or derived air concentrations based on the committed effective dose equivalent.

(b) For an annual limit on intake and the associated derived air concentration determined by the nonstochastic organ dose limit of 50 rems, the intake of radionuclides that would result in a committed effective dose equivalent of 5 rems is listed in parentheses in Table I of Appendix B. In this case, the licensee may use the stochastic annual limit on intake to determine the committed effective dose equivalent. If the licensee uses the stochastic annual limit on intake, the licensee shall also demonstrate that the limits specified in subparagraph (2) of paragraph (a) of subsection 1 of NAC 459.325 are met.

(Added to NAC by Bd. of Health, eff. 1-18-94)

NAC 459.329 Requirements for planned special exposures. (NRS 459.201) A licensee or registrant may permit a worker who is an adult to receive a planned special exposure, in addition to and accounted for separately from the doses received under the limits specified in NAC 459.325, if each of the following conditions is satisfied:

1. The licensee or registrant notifies the Division of the planned special exposure in writing at least 10 working days before the planned special exposure is scheduled to occur, and verifies that the Division has received the letter of notification.

2. The planned special exposure is to occur in an exceptional situation when alternatives that might avoid the higher exposure are unavailable or impractical.

3. The licensee or registrant, and employer if the employer is not the licensee or registrant, specifically authorizes the planned special exposure, in writing, before the exposure occurs.

4. Before the planned special exposure, the licensee or registrant ensures that each person involved is:

(a) Informed of the purpose of the planned special exposure;

(b) Informed of the estimated doses and associated potential risks, and the specific radiation levels or other conditions that might be involved in performing the task; and

(c) Instructed in the measures to be taken to keep the dose as low as is reasonably achievable considering other risks that may be present.

5. Before permitting a person to participate in a planned special exposure, the licensee or registrant ascertains previous doses received by the person during his or her lifetime as required pursuant to NAC 459.365.

6. The planned special exposure would not cause a person to receive a dose from all planned special exposures and all doses in excess of:

(a) The numerical values of any of the limits specified in subsection 1 of NAC 459.325 in any year; and

(b) Five times the annual limits specified in subsection 1 of NAC 459.325 during the lifetime of the person.

7. The licensee or registrant maintains records of the conduct of the planned special exposure in accordance with NAC 459.3655 and submits a written report in accordance with NAC 459.3715.

8. The licensee or registrant records the best estimate of the dose resulting from the planned special exposure in the record of the person receiving the dose and informs that person, in writing, of the dose within 30 days after the date of the planned special exposure. The dose from planned special exposures must not be considered in controlling the future occupational dose of the person pursuant to subsection 1 of NAC 459.325, but must be included in the determinations required to be made pursuant to subsections 5 and 6.

(Added to NAC by Bd. of Health, eff. 1-18-94)

NAC 459.331 Annual limits for occupational doses for minors. (NRS 459.201) The limits for the annual occupational dose for minors are 10 percent of the limits for the annual occupational dose specified in NAC 459.325 for adult workers.

(Added to NAC by Bd. of Health, eff. 1-18-94)

NAC 459.333 Dose equivalents to embryos. (NRS 459.030, 459.201)

1. Except as otherwise provided in subsection 4, a licensee or registrant shall ensure that the dose equivalent to an embryo during the entire pregnancy, resulting from occupational exposure of a woman who has declared her pregnancy, does not exceed 0.5 rem (5 millisieverts).

2. The licensee or registrant shall make efforts to avoid any substantial variation from a uniform monthly exposure rate to a woman who has declared her pregnancy so as to satisfy the limits specified in subsection 1.

3. The dose equivalent to an embryo is the sum of:

(a) The deep-dose equivalent to the woman who has declared her pregnancy; and

(b) The dose equivalent to the embryo resulting from radionuclides in the embryo and radionuclides in the woman who has declared her pregnancy.

4. If, by the time a woman declares her pregnancy to the licensee or registrant, the dose equivalent to the embryo has exceeded 0.5 rem (5 millisieverts), or is within 0.05 rem (0.5 millisievert) of that dose, the licensee or registrant shall be deemed to be in compliance with subsection 1 if the additional dose equivalent to the embryo does not exceed 0.05 rem (0.5 millisievert) during the remainder of the pregnancy.

(Added to NAC by Bd. of Health, eff. 1-18-94; A by Dep't of Human Resources by R137-01, 5-30-2003)

NAC 459.335 Dose limits for individual members of public; application for authorization to increase annual dose limit; imposition of additional restrictions; standards for nuclear power operations. (NRS 459.030, 459.201)

1. Except as otherwise provided in this section and subsection 2 of NAC 459.321, each licensee and registrant shall conduct operations to ensure that:

(a) The total effective dose equivalent to any member of the public from its licensed or registered operation does not exceed 0.1 rem (1 millisievert) per year, not including the dose contribution from background radiation, any medical administration the member of the public has received, exposure to natural persons who have been administered radioactive material and have been released from the control of a licensee pursuant to 10 C.F.R. § 35.75, voluntary participation in medical research, and the disposal by the licensee of radioactive material into sanitary sewerage in accordance with NAC 459.3605; and

(b) The dose in any unrestricted area from external sources, not including the dose contributions from natural persons who have been administered radioactive material and have been released from the control of a licensee pursuant to 10 C.F.R. § 35.75, does not exceed 0.002 rem (0.02 millisievert) in any 1 hour.

2. Notwithstanding the provisions of paragraph (a) of subsection 1, a licensee may allow a visitor to a person who cannot be released pursuant to 10 C.F.R. § 35.75 to receive a radiation dose greater than 0.1 rem (1 millisievert) if:

(a) The radiation dose does not exceed 0.5 rem (5 millisieverts); and

(b) Before the visit, the licensee has determined that the visit is appropriate.

3. A licensee, a registrant or an applicant for a license or registration may apply to the Division for authorization to operate up to an annual dose limit for a member of the public of 0.5 rem (5 millisieverts) per year. The application must include:

(a) A demonstration of the need for and the expected duration of operations in excess of the limit specified in paragraph (a) of subsection 1;

(b) A description of the program of the licensee or registrant to assess and control the dose within the annual limit of 0.5 rem (5 millisieverts); and

(c) The procedures to be followed to maintain the dose as low as is reasonably achievable.

4. The Division may impose additional restrictions on radiation levels in unrestricted areas and on the total quantity of radionuclides that a licensee may release in effluents in order to restrict the collective dose.

5. In addition to the requirements of this section, a licensee who is subject to the provisions of 40 C.F.R. Part 190 shall comply with the standards set forth therein.

(Added to NAC by Bd. of Health, eff. 1-18-94; A by Dep't of Human Resources by R137-01, 5-30-2003; A by Bd. of Health by R085-06, 11-13-2006)

NAC 459.3355 Compliance with dose limits for individual members of public. (NRS 459.201)

1. A licensee or registrant shall make or cause to be made surveys of radiation levels in unrestricted areas and radioactive materials in effluents released to unrestricted areas in order to demonstrate compliance with the limits specified in NAC 459.335 for members of the public.

2. A licensee or registrant shall demonstrate compliance with the annual limits specified in NAC 459.335 by:

(a) Demonstrating by measurement or calculation that the total effective dose equivalent to the member of the public likely to receive the highest dose from the licensed or registered operation does not exceed the annual limits; or

(b) Demonstrating that:

(1) The annual average concentrations of radioactive material released in gaseous and liquid effluents at the boundary of the unrestricted area do not exceed the values specified in Table II of Appendix B; and

(2) If a person were continually present in an unrestricted area, the dose from external

sources would not exceed 0.002 rem in 1 hour and 0.05 rem in 1 year.

3. Upon approval from the Division, the licensee may adjust the concentration values for effluents in Table II of Appendix B for members of the public to take into account the actual physical and chemical characteristics of the effluents.

(Added to NAC by Bd. of Health, eff. 1-18-94)

NAC 459.336 Orders requiring bioassay services. (NRS 459.201) Where necessary or desirable in order to aid in determining the extent of a person's exposure to concentrations of radioactive material, the Division may incorporate license provisions or issue an order requiring a licensee or registrant to make available to the person appropriate bioassay services and to furnish a copy of the reports of those services to the Division.

[Bd. of Health, Radiation Control Reg. § 4.2.7, eff. 2-28-80]

NAC 459.337 Surveys and monitoring. (NRS 459.030, 459.201)

1. Each licensee and registrant shall make, or cause to be made, surveys that:

(a) Are necessary for the licensee or registrant to comply with NAC 459.010 to 459.950, inclusive; and

(b) Are necessary under the circumstances to evaluate:

(1) The magnitude and extent of radiation levels;

(2) Concentrations or quantities of radioactive material; and

(3) The potential radiological hazards.

2. The Division may exempt a licensee or registrant from the requirements of subsection 1 if the Division determines that the exemption will not result in a significant risk to public health and safety.

3. The licensee or registrant shall ensure that instruments and equipment used for quantitative radiation measurements are calibrated for the radiation measured at intervals not to exceed 12 months.

4. All personnel dosimeters, except for direct and indirect reading pocket ionization chambers and those dosimeters used to measure the dose to any extremity, that require processing to determine the dose of radiation and that are used by licensees and registrants to comply with NAC 459.325, with other applicable provisions of NAC 459.010 to 459.950, inclusive, or with conditions specified in a license or registration, must be processed and evaluated by a dosimetry processor who is accredited by the National Voluntary Laboratory Accreditation Program of the National Institute of Standards and Technology for the type of radiation or radiations included in the program that most closely approximate the type of radiation for which the person wearing the dosimeter is monitored.

5. The licensee or registrant shall ensure that adequate precautions are taken to prevent a deceptive exposure of personnel monitoring equipment.

(Added to NAC by Bd. of Health, eff. 1-18-94; A by R084-98, 1-26-99; A by Dep't of Human Resources by R137-01, 5-30-2003; A by Bd. of Health by R149-07, 1-30-2008; R185-08, 5-7-2010)

NAC 459.339 Precautionary procedures: Conditions requiring individual monitoring of external and internal occupational doses. (NRS 459.030, 459.201) Each licensee and registrant shall monitor exposures from sources of radiation at levels sufficient to demonstrate compliance with the limits for occupational doses specified in NAC 459.010 to 459.950, inclusive. As a minimum:

1. Each licensee and registrant shall monitor occupational exposure to radiation from licensed and unlicensed sources under the control of the licensee or registrant and shall supply

and require the use of personnel monitoring equipment by:

(a) Adults who are likely to receive in 1 year, from sources of radiation external to the body, a dose in excess of 10 percent of the limits specified in NAC 459.325;

(b) Minors who are likely to receive in 1 year, from sources of radiation external to the body, a deep-dose equivalent in excess of 0.1 rem (1 millisievert), a lens dose equivalent in excess of 0.15 rem (1.5 millisieverts), or a shallow-dose equivalent to the skin or extremities in excess of 0.5 rem (5 millisieverts);

(c) Women who have declared their pregnancy and are likely to receive, during the entire pregnancy, from sources of radiation external to the body, a deep-dose equivalent in excess of 0.1 rem (1 millisievert); and

(d) Any person entering a high or very high radiation area.

2. Each licensee shall monitor, to determine compliance with NAC 459.3275, the occupational intake of radioactive material by and assess the committed effective dose equivalent to:

(a) Adults who are likely to receive, in 1 year, an intake in excess of 10 percent of the applicable annual limit on intake in columns 1 and 2 of table I of appendix B;

(b) Minors who are likely to receive, in 1 year, a committed effective dose equivalent in excess of 0.1 rem (1 millisievert); and

(c) Women who have declared their pregnancy and are likely to receive, during the entire pregnancy, a committed effective dose equivalent in excess of 0.1 rem (1 millisievert).

(Added to NAC by Bd. of Health, eff. 1-18-94; A by R084-98, 1-26-99; A by Dep't of Human Resources by R137-01, 5-30-2003; A by Bd. of Health by R149-07, 1-30-2008)

NAC 459.341 Precautionary procedures: Control of access to high radiation areas. (NRS 459.201)

1. Except as otherwise provided in this section, a licensee or registrant shall ensure that each entrance to a high radiation area has one or more of the following features:

(a) A control device that, upon entry into the radiation area, causes the level of radiation to be reduced below the level at which a person could receive a deep-dose equivalent of 0.1 rem in 1 hour at 30 centimeters from the source of radiation or from any surface that the radiation penetrates.

(b) A control device that energizes a conspicuous visible or audible alarm so that a person entering the high radiation area and the supervisor of the activity in the area are made aware of the entry.

(c) Entrances that are locked, except during periods when access to the area is required with positive control over each individual entrance.

2. In place of the controls required pursuant to subsection 1, the licensee or registrant may substitute continuous direct or electronic surveillance that is capable of preventing unauthorized entry into the radiation area.

3. The licensee or registrant may apply to the Division for authorization to use alternative methods for controlling access to high radiation areas.

4. The licensee or registrant shall establish the controls required pursuant to subsections 1 and 3 in a manner that does not prevent a person from leaving a high radiation area.

5. The licensee is not required to control each entrance to a high radiation area that contains only radioactive materials prepared for transport and packaged and labeled in accordance with the regulations of the United States Department of Transportation if:

(a) The packages do not remain in the area for more than 3 days; and

(b) The dose at 1 meter from the external surface of any package does not exceed 0.01 rem per hour.

6. The licensee is not required to control each entrance to a room or other area in a hospital solely because of the presence of a patient whose treatment requires the use of radioactive material if there are persons in attendance who will take the necessary precautions to:

(a) Prevent the exposure of a person to radiation or radioactive material in excess of the limits specified in NAC 459.325, 459.331, 459.333 and 459.335; and

(b) Ensure that any doses are as low as are reasonably achievable.

(Added to NAC by Bd. of Health, eff. 1-18-94)

NAC 459.343 Precautionary procedures: Control of access to very high radiation areas. (NRS 459.201) In addition to the requirements specified in NAC 459.341, a licensee or registrant shall institute measures to ensure that a person is not able to gain unauthorized or inadvertent access to areas in which radiation levels could be encountered at 500 rads or more in 1 hour at 1 meter from a source of radiation or any surface through which the radiation penetrates.

(Added to NAC by Bd. of Health, eff. 1-18-94)

NAC 459.345 Precautionary procedures: Control of access to very high radiation area with sealed radioactive sources used to irradiate materials. (NRS 459.201)

1. Except as otherwise provided in this section, each area in which there may exist radiation levels in excess of 500 rads in 1 hour at 1 meter from a sealed radioactive source that is used to irradiate materials must meet the following requirements:

(a) Each entrance must be equipped with entry control devices which:

(1) Function automatically to prevent any person from inadvertently entering a very high radiation area;

(2) Permit deliberate entry into the area only after the control device is actuated and causes the radiation level within the area, from the source of radiation, to be reduced below that at which it would be possible for a person to receive a deep-dose equivalent in excess of 0.1 rem in 1 hour; and

(3) Prevent operation of the source of radiation if it would produce radiation levels in the area that could result in a deep-dose equivalent to a person in excess of 0.1 rem in 1 hour.

(b) Additional control devices must be provided so that, upon failure of the entry control devices to function as required pursuant to paragraph (a):

(1) The radiation level within the area, from the source of radiation, is reduced below the level at which it would be possible for a person to receive a deep-dose equivalent in excess of 0.1 rem in 1 hour; and

(2) Conspicuous visible and audible alarms are generated to make any person who is attempting to enter the area aware of the hazard and to make at least one other authorized person, who is physically present, familiar with the activity and prepared to render or summon assistance, aware of the failure of the entry control devices.

(c) The licensee shall provide control devices that ensure that, upon the failure or removal of physical radiation barriers other than the shielded storage container of the sealed source:

(1) The radiation level from the source is reduced below the level at which it would be possible for a person to receive a deep-dose equivalent in excess of 0.1 rem in 1 hour; and

(2) Conspicuous visible and audible alarms are generated to make potentially affected persons aware of the hazard and to make the licensee, or at least one other person who is familiar with the activity and prepared to render or summon assistance, aware of the failure or removal of

the physical barrier.

(d) When the shield for stored sealed sources is a liquid, the licensee shall provide a means to monitor the integrity of the shield and to signal, automatically, loss of adequate shielding.

(e) Physical radiation barriers that comprise permanent structural components and have no reasonable probability of failure or removal in ordinary circumstances are not required to meet the requirements of paragraph (c) or (d).

(f) Each area must be equipped with devices that will automatically generate conspicuous visible and audible alarms to alert persons in the area before the source of radiation can be put into operation and in time for any persons in the area to operate a clearly identified control device, which must be installed in the area and which is able to prevent the source of radiation from being put into operation.

(g) Each area must be controlled by the use of such administrative procedures and such devices as are necessary to ensure that the area is cleared of persons before each use of the source of radiation.

(h) Each area must be checked by a radiation measurement to ensure that, before any person enters the area after any use of the source of radiation, the radiation level from the source of radiation in the area is below the level at which it would be possible for a person to receive a deep-dose equivalent in excess of 0.1 rem in 1 hour.

(i) The entry control devices required pursuant to paragraph (a) must be tested for proper functioning in the following manner:

(1) Testing must be conducted before the initial operation of the source of radiation on any day, unless operations were continued uninterrupted from the previous day;

(2) Testing must be conducted before the resumption of operation of the source of radiation after any unintentional interruption; and

(3) The licensee shall submit and adhere to a schedule for periodic tests of the entry control devices and warning systems.

(j) The licensee shall not conduct operations, other than those necessary to place the source of radiation in safe condition or to effect repairs on control devices, unless control devices are functioning properly.

(k) Entry and exit portals that are used in transporting materials to and from the area and that are not intended for use by persons to enter or exit the area, must be controlled by such devices and administrative procedures as are necessary to protect and warn against inadvertent entry by any person through these portals. Exit portals which are for irradiated materials must be equipped to detect and signal the presence of any loose radioactive material that is carried toward such a portal and automatically to prevent loose radioactive material from being carried out of the area.

2. Licensees or applicants for licenses who are subject to the provisions of subsection 1 and will use the source of radiation in a variety of positions or in locations which make it impracticable to comply with the requirements of subsection 1, may apply to the Division for approval of alternative safety measures. Alternative safety measures must provide persons with protection that is at least equivalent to the protection specified in subsection 1. At least one of the alternative measures must include an inter-lock control device that is designed to prevent entry based on a measurement of the radiation and that ensures the absence of high radiation levels before a person can gain access to the area where such sources of radiation are used.

3. The entry control devices required by subsections 1 and 2 must be established in such a manner that no person will be prevented from leaving the area.

4. As used in this section, sealed radioactive source means any by-product, source or special nuclear material that is used in sealed sources in irradiators that are not self-shielded.

(Added to NAC by Bd. of Health, eff. 1-18-94)

NAC 459.347 Precautionary procedures: Use of process or other engineering controls; alternative controls; consideration of other safety factors. (NRS 459.201)

1. A licensee shall use, to the extent practicable, process or other engineering controls, including, without limitation, containment, decontamination and ventilation, to control the concentrations of radioactive material in the air.

2. If it is not practicable to apply process or other engineering controls to control the concentrations of radioactive material in the air to levels below those that define an area of airborne radioactivity, the licensee shall, consistent with maintaining the total effective dose equivalent as low as is reasonably achievable, increase monitoring and limit intakes by one or more of the following:

(a) Controlling access to the area;

(b) Limiting exposure times;

(c) Using respiratory protective devices; or

(d) Using any other means available to control concentrations of radioactive material in the air.

3. If the licensee performs an analysis of exposures to radiation to determine what exposure level is as low as is reasonably achievable and to determine whether respiratory protective devices should be used, the licensee may consider safety factors other than radiological safety factors, including, without limitation, consideration of the effect of respiratory protective devices on the industrial health and safety of workers.

(Added to NAC by Bd. of Health, eff. 1-18-94; A by R085-06, 11-13-2006)

NAC 459.349 Precautionary procedures: Use of respiratory protective devices. (NRS 459.201)

1. If a licensee uses respiratory protective devices to limit intakes as required pursuant to NAC 459.347, the licensee shall comply with the following requirements:

(a) Except as otherwise provided in paragraph (b), the licensee shall use only a respiratory protective device that is tested and certified, or has had certification extended, by the National Institute for Occupational Safety and Health.

(b) If the licensee wishes to use equipment that has not been tested or certified by the National Institute for Occupational Safety and Health, or for which there is no schedule for testing or certification, the licensee shall submit an application for authorized use of that equipment. The application must include evidence that the material and performance characteristics of the equipment are capable of providing the proposed degree of protection under anticipated conditions of use. The evidence must be acquired from tests performed on the equipment by the licensee or based on information obtained from other reliable tests that have been performed on the equipment.

(c) The licensee shall implement and maintain a program for respiratory protection that includes, without limitation:

(1) A sampling of the air that is sufficient to identify any potential hazard, permit the proper selection of equipment and estimate doses;

(2) Surveys and bioassays, as necessary, to evaluate actual intakes;

(3) Testing respiratory protective devices for operability immediately before each use, including, without limitation, user-performed seal checks for face-sealing respirators and

functional checks for all other respirators;

(4) Written procedures regarding:

(I) Testing, including, without limitation, fit testing;

(II) The supervision and training of users of respiratory protective devices;

(III) Recordkeeping;

(IV) Monitoring, including, without limitation, sampling air and bioassays;

(V) Selection of respiratory protective devices;

(VI) Breathing air quality;

(VII) Inventory and control of respiratory protective devices;

(VIII) Storage, issuance, maintenance, repair and quality assurance of respiratory protective devices; and

(IX) Limitations on periods of use of respiratory protective devices and relief from use of respiratory protective devices; and

(5) The determination by a physician that each user of a face-sealing respirator or nonface-sealing respirator is medically fit to use the respirator before the initial fitting of a face-sealing respirator or before the first use of a nonface-sealing respirator and:

(I) At least once every 12 months after the initial fitting; or

(II) Periodically at a frequency that is determined by the physician.

(d) The licensee shall perform fit testing for a respirator before the first field use of a respirator with a tight-fitting facepiece and not less than annually thereafter. The fit test must be performed with the facepiece of the respirator operating in the negative pressure mode and the fit factor:

(1) For a negative pressure respirator must be greater than or equal to 10 times the air pressure flow; and

(2) For a positive pressure, continuous flow or pressure demand respirator must exceed 500.

(e) The licensee shall advise each user of a respiratory protective device that the user may leave the area at any time for relief from the use of the respiratory protective device if:

(1) The device malfunctions;

(2) He or she suffers physical or psychological distress;

(3) There is a failure of communication or procedures;

(4) There is a significant deterioration in the operating conditions; or

(5) There are any other conditions that might require relief from use of the device.

(f) The licensee shall:

(1) Consider limitations appropriate to the type of respiratory protective device and the intended mode of use of the respiratory protective device;

(2) When selecting a respiratory protective device, provide for vision correction, adequate communication, low-temperature work environments and the concurrent use of other safety and radiological protection equipment; and

(3) Use equipment in a manner that does not interfere with the proper operation of the respiratory protective device.

(g) The licensee shall provide standby rescue personnel when a person is using a one-piece atmosphere-supplying suit or any combination of a supplied-air respirator and personnel protective equipment from which the person would have difficulty extricating himself or herself. The standby rescue personnel must:

(1) Be equipped with respiratory protective devices or other equipment appropriate to the

potential hazards.

(2) Visually observe the person who is using a one-piece atmosphere-supplying suit or any combination of a supplied-air respirator and personnel protective equipment or maintain continuous communication with such person through visual, voice, signal line, telephone, radio or other suitable means of communication.

(3) Be immediately available to assist the person who is using a one-piece atmosphere-supplying suit or any combination of a supplied-air respirator and personnel protective equipment in case of a failure of air supply or for any other reason that requires relief from distress.

(4) Be sufficient in number and training to provide immediate assistance to the person who is using a one-piece atmosphere-supplying suit or any combination of a supplied-air respirator and personnel protective equipment and to provide effective emergency rescue if needed.

(h) The licensee shall ensure that atmosphere-supplying respirators are supplied with desirable air of grade D quality or better as defined in Publication G-7.1, *Commodity Specification for Air* (1997), and the provisions of 29 C.F.R. §§ 1910.134(i)(1)(ii)(A) to 1910.134(i)(1)(ii)(E), inclusive. A hard copy of Publication G-7.1, *Commodity Specification for Air* (1997), published by the Compressed Gas Association, may be obtained at a cost of $32 for a member of the Compressed Gas Association or $58 for a nonmember at the Internet address **http://www.cganet.com/publication.asp**. An electronic copy of the publication may be obtained free of charge for a member of the Compressed Gas Association or at a cost of $44 for a nonmember at the Internet address **http://www.cganet.com/publication.asp**.

(i) The licensee shall ensure that no objects, materials or substances, including, without limitation, facial hair, or any conditions which could interfere with the face-to-facepiece seal or valve function and which are under the control of the user of the respirator are present between the skin of the face of the user of the respirator and the sealing surface of a tight-fitting facepiece.

(j) In measuring the dose to persons from the intake of airborne radioactive material, the licensee must assume initially that the concentration of radioactive material in the air that is inhaled when a respirator is worn is the ambient concentration of radioactive material in the air without a respirator divided by the assigned protection factor of the respirator. If the licensee later finds that the actual dose is greater than the estimated dose, the actual dose must be used. If the actual dose is later found to be less than the estimated dose, the actual dose may be used.

2. A licensee shall obtain authorization from the Division before using assigned respiratory protection factors in excess of those specified in Appendix A. The Division may authorize a licensee to use higher assigned protection factors upon receipt of an application that:

(a) Describes the situation for which a need exists for higher protection factors; and

(b) Demonstrates that the respiratory protective device provides these higher protection factors under the proposed conditions of use.

3. In addition to any restrictions imposed pursuant to the provisions of this section and NAC 459.347, the Division may impose restrictions on the use of respiratory protective devices by a licensee to:

(a) Ensure that the respiratory protection program of the licensee is adequate to limit doses to persons from the intake of airborne radioactive material consistent with maintaining the total effective dose equivalent as low as is reasonably achievable; and

(b) Limit the extent to which a licensee may use respiratory protective devices instead of

processes or engineering controls to limit doses to persons from the intake of airborne radioactive material.

(Added to NAC by Bd. of Health, eff. 1-18-94; A by R084-98, 1-26-99; A by R085-06, 11-13-2006)

NAC 459.352 Precautionary procedures: Radiation machines. (NRS 459.201) All radiation machines must be labeled in a manner which cautions people that radiation is produced when the machine is being operated.

[Bd. of Health, Radiation Control Reg. § 4.3.3.7, eff. 2-28-80]

NAC 459.3525 Precautionary procedures: Control of licensed radioactive material and radiation machines in unrestricted areas and not in storage. (NRS 459.201)

1. A licensee shall control and maintain constant surveillance of licensed radioactive material that is in an unrestricted area and that is not in storage or related to the care of a patient.

2. A registrant shall maintain control of radiation machines that are in an unrestricted area and that are not in storage.

(Added to NAC by Bd. of Health, eff. 1-18-94)

NAC 459.353 Precautionary procedures: Security of stored material. (NRS 459.201) A licensee or registrant shall secure from unauthorized removal or access licensed or registered sources of radiation that are stored in unrestricted areas.

(Added to NAC by Bd. of Health, eff. 1-18-94)

NAC 459.354 Precautionary procedures: Instruction of personnel. (NRS 459.201) Instructions are required for persons working in or frequenting any portion of a restricted area as specified in NAC 459.784.

[Bd. of Health, Radiation Control Reg. § 4.3.5, eff. 2-28-80]

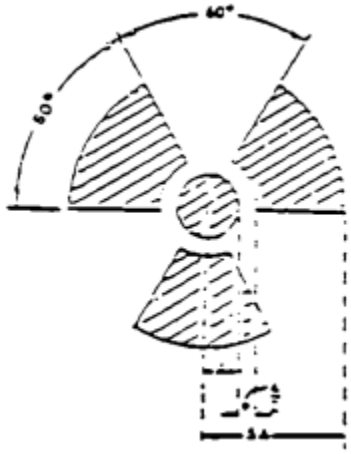
NAC 459.355 Precautionary procedures: Radiation symbol; labels; additional information. (NRS 459.201)

1. Except as otherwise provided in this section or as otherwise authorized by the Division, a licensee or registrant shall use a radiation symbol with a three-bladed design as follows:

(a) Each cross-hatched area must be magenta, purple or black; and

(b) The background must be yellow.

Radiation symbol



2. A licensee may label sources of radiation, holders for sources of radiation or device components containing sources of radiation that are subjected to high temperatures with conspicuously etched or stamped radiation symbols that do not comply with the requirements for color set forth in subsection 1.

3. In addition to the contents of signs and labels required by NAC 459.010 to 459.950, inclusive, a licensee or registrant shall provide, on or near the required signs and labels, additional information, as appropriate, to make persons aware of potential exposures and to minimize those exposures.

4. A radiation symbol or the labels described in NAC 459.010 to 459.950, inclusive, must only be used when conditions exist that warrant their use.

(Added to NAC by Bd. of Health, eff. 1-18-94; A by R084-98, 1-26-99; R149-07, 1-30-2008)

NAC 459.3555 Precautionary procedures: Requirements for posting signs. (NRS 459.201) Except as otherwise provided in NAC 459.3565:

1. A licensee or registrant shall post in each radiation area a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, RADIATION AREA."

2. A licensee or registrant shall post in each high radiation area a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, HIGH RADIATION AREA" or "DANGER, HIGH RADIATION AREA."

3. A licensee or registrant shall post in each very high radiation area a conspicuous sign or signs bearing the radiation symbol and the words "GRAVE DANGER, VERY HIGH RADIATION AREA."

4. A licensee shall post in each area of airborne radioactivity a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, AIRBORNE RADIOACTIVITY AREA" or "DANGER, AIRBORNE RADIOACTIVITY AREA."

5. A licensee shall post in each area or room in which there is used or stored an amount of licensed radioactive material exceeding 10 times the quantity of such material specified in Appendix C a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, RADIOACTIVE MATERIAL(S)" or "DANGER, RADIOACTIVE MATERIAL(S)."

(Added to NAC by Bd. of Health, eff. 1-18-94)

NAC 459.3565 Precautionary procedures: Exceptions to requirements for posting signs. (NRS 459.030, 459.201)

1. A licensee or registrant is not required to post signs pursuant to NAC 459.3555 in an area or room containing sources of radiation for periods of less than 8 hours if:

(a) The sources of radiation are constantly attended during these periods by a person who takes the precautions necessary to prevent the exposure of persons to sources of radiation in excess of the limits established in NAC 459.325, 459.331, 459.333 and 459.335; and

(b) The area or room is subject to the control of the licensee or registrant.

2. A room or other area in a hospital that is occupied by a patient is not required to be posted with signs pursuant to NAC 459.3555 if:

(a) The patient is being treated with sealed sources of radiation or has been treated with unsealed radioactive material in quantities of less than 30 millicuries (1.11 gigabecquerels), or the measured dose rate at 1 meter from the patient is less than 0.005 rem (0.05 millisievert) per hour;

(b) The licensee is authorized to release the patient from confinement pursuant to 10 C.F.R. § 35.75; and

(c) There are personnel in attendance who will take the necessary precautions to prevent the exposure of persons to radiation or radioactive materials in excess of the limits specified in NAC 459.325, 459.331, 459.333 and 459.335, and to maintain the level of radiation at a level which is as low as is reasonably achievable.

3. A room or area is not required to be posted with signs pursuant to NAC 459.3555 because of the presence of a sealed source of radiation if the level of radiation at 30 centimeters from the surface of the container or housing for the sealed source does not exceed 0.005 rem (0.05 millisievert) per hour.

4. A room in a hospital or clinic that is used for teletherapy is not required to be posted with signs pursuant to NAC 459.3555 if there are personnel in attendance who will take the necessary precautions to prevent the exposure of any person to radiation or radioactive materials in excess of the limits established in NAC 459.325, 459.331, 459.333 and 459.335, and to maintain the level of radiation at a level that is as low as is reasonably achievable.

(Added to NAC by Bd. of Health, eff. 1-18-94; A by Dep't of Human Resources by R137-01, 5-30-2003; A by Bd. of Health by R085-06, 11-13-2006)

NAC 459.357 Precautionary procedures: Requirements for labeling containers and radiation machines. (NRS 459.201) Except as otherwise provided in NAC 459.3575:

1. Each licensee shall ensure that each container of licensed radioactive material bears a durable, clearly visible label bearing the radiation symbol and the words "CAUTION, RADIOACTIVE MATERIAL" or "DANGER, RADIOACTIVE MATERIAL." The label must provide information to permit persons handling or using the container, or working in the vicinity of the container, to take precautions to avoid or minimize exposures. The information on the label may include, but is not limited to:

(a) The radionuclides present;

(b) An estimate of the quantity of radioactivity;

(c) The date for which the activity is estimated;

(d) The levels of radiation;

(e) The kinds of radioactive materials present; and

(f) The mass enrichment.

2. Each licensee shall, before the removal or disposal of empty uncontaminated containers in unrestricted areas, remove or deface the label required pursuant to subsection 1, or otherwise clearly indicate that the container no longer contains radioactive material.

3. Each registrant shall ensure that each radiation machine is labeled in a conspicuous manner which cautions persons that radiation is produced when the machine is energized.

(Added to NAC by Bd. of Health, eff. 1-18-94)

NAC 459.3575 Precautionary procedures: Exceptions to requirements for labeling containers. (NRS 459.201) A licensee is not required to label a container pursuant to NAC 459.357 if the container is:

1. Holding licensed radioactive material in quantities that are less than the quantities listed in Appendix C.

2. Holding licensed radioactive material in concentrations that are less than those specified in Table III of Appendix B.

3. Attended by a person who takes the precautions necessary to prevent the exposure of persons in excess of the limits established by NAC 459.010 to 459.950, inclusive.

4. In transport and is packaged and labeled in accordance with the regulations of the United States Department of Transportation.

5. Accessible only to persons authorized to work in the vicinity of the container or authorized to handle or use the container, if the contents of the container are identified to those persons by a readily available written record which is retained while the container is in use for the purpose indicated on the record.

6. Installed manufacturing or process equipment.

(Added to NAC by Bd. of Health, eff. 1-18-94; A by R084-98, 1-26-99; R149-07, 1-30-2008)

NAC 459.3585 Precautionary procedures: Receiving, monitoring and opening packages. (NRS 459.201)

1. Each licensee who expects to receive a package containing quantities of radioactive material in excess of a type A quantity, as defined in 10 C.F.R. § 71.4, as that section existed on November 14, 2007, shall make arrangements to receive:

(a) The package when the carrier offers it for delivery; or

(b) Notification of the arrival of the package at the terminal of the carrier and to take possession of the package expeditiously.

2. Except as otherwise provided in subsection 6, each licensee shall monitor the external surfaces of a package known to contain radioactive material for radioactive contamination and radiation levels if the package:

(a) Is labeled as containing radioactive material; or

(b) Has evidence of potential contamination.

3. The licensee shall perform the monitoring required by subsection 2 as soon as practicable after receipt of the package, but not later than 3 hours after the package is received at the facility of the licensee if the package is received during the normal working hours of the licensee. If the package is received after the normal working hours of the licensee, the monitoring must be performed not later than 3 hours after the beginning of the next normal working day of the licensee.

4. A licensee shall immediately notify the carrier who made the final delivery of a package and, by telephone and telegram, mailgram or facsimile, the Division if:

(a) Removable radioactive contamination on the surface of the package is detected that exceeds 22,000 disintegrations per minute per 100 square centimeters of package surface; or

(b) The radiation level at 1 meter from the surface of the package exceeds 10 milliroentgens per hour.

5. Each licensee shall:

(a) Establish, maintain and retain written procedures for safely opening packages in which radioactive material is received; and

(b) Ensure that the procedures established pursuant to paragraph (a) are followed and that consideration is given to any special instructions for the type of package being opened.

6. A licensee transferring a source of radiation in a special form in a motor vehicle owned or operated by the licensee to and from a work site is not required to comply with the requirements of subsection 2, but shall ensure that the source of radiation is still properly lodged in its shield.

(Added to NAC by Bd. of Health, eff. 1-18-94; A by R185-08, 5-7-2010)

NAC 459.359 Disposal of waste: General requirements. (NRS 459.201)

1. A licensee shall dispose of licensed radioactive material only:

(a) By transfer to an authorized recipient as provided in NAC 459.180 to 459.313, inclusive, and 459.8231 to 459.950, inclusive;

(b) By decay in storage;

(c) By release in effluents within the limits specified in NAC 459.335; or

(d) As authorized pursuant to NAC 459.3595 to 459.3615, inclusive.

2. A person must be licensed by the Division to receive waste containing licensed radioactive material from other persons for:

(a) Treatment before disposal;

(b) Treatment or disposal by incineration;

(c) Decay in storage;

(d) Disposal at a land disposal facility licensed pursuant to NAC 459.806 to 459.8225, inclusive; or

(e) Storage until it is transferred to a storage or disposal facility authorized to receive the waste.

(Added to NAC by Bd. of Health, eff. 1-18-94; A by R084-98, 1-26-99; R149-07, 1-30-2008)

NAC 459.3595 Disposal of waste: Application for approval of proposed procedures. (NRS 459.201) A licensee or applicant for a license may apply to the Division for approval of proposed procedures, not otherwise authorized pursuant to NAC 459.010 to 459.950, inclusive, to dispose of licensed radioactive material generated in the operations of the licensee. Each application must include:

1. A description of the waste containing the licensed radioactive material to be disposed of, including, without limitation, the physical and chemical properties that have an impact on evaluating the risk of the proposed procedures, and the proposed manner and conditions of disposing of the waste;

2. An analysis and evaluation of pertinent information related to the impact of the proposed procedures on the environment;

3. The nature and location of other potentially affected facilities; and

4. Analyses and procedures to ensure that doses are maintained as low as are reasonably achievable and within the limits specified in NAC 459.325, 459.331, 459.333 and 459.335.

(Added to NAC by Bd. of Health, eff. 1-18-94; A by R084-98, 1-26-99; R149-07, 1-30-2008)

NAC 459.3605 Disposal of waste: Release into sanitary sewerage. (NRS 459.201)

1. Except as otherwise provided in subsection 2, a licensee may discharge licensed radioactive material into sanitary sewerage only if each of the following conditions is satisfied:

(a) The material is readily soluble in water or is readily dispersible biological material in water.

(b) The quantity of all radioactive material that the licensee releases into the sanitary sewerage in 1 month divided by the average monthly volume of water released into the sanitary sewerage by the licensee does not exceed the concentration of radioactive material listed in Table III of Appendix B.

(c) The total quantity of all radioactive material that the licensee releases into the sanitary sewerage in 1 year does not exceed 5 curies of hydrogen-3, 1 curie of carbon-14 and 1 curie of all other radioactive materials combined.

(d) If more than one radionuclide is released:

(1) The licensee determines the fraction of the limits in Table III of Appendix B

represented by discharges into sanitary sewerage by dividing the actual monthly average concentration of each radionuclide released by the licensee into the sanitary sewerage by the concentration of that radionuclide listed in Table III of Appendix B; and

(2) The sum of the fractions for each radionuclide required by subparagraph (1) does not exceed unity.

2. Excreta from persons undergoing medical diagnosis or therapy with radioactive material is not subject to the limitations contained in subsection 1.

(Added to NAC by Bd. of Health, eff. 1-18-94; A by R084-98, 1-26-99)

NAC 459.361 Disposal of waste: Treatment or disposal by incineration. (NRS 459.201) A licensee may treat or dispose of licensed radioactive material by incineration only in the amounts and forms:

1. Specified in NAC 459.3615; or
2. Approved by the Division pursuant to NAC 459.3595.

(Added to NAC by Bd. of Health, eff. 1-18-94)

NAC 459.3615 Disposal of waste: Specific wastes. (NRS 459.201)

1. Except as otherwise provided in subsection 2, a licensee may dispose of the following licensed radioactive material as if it were not radioactive:

(a) Not more than 0.05 microcurie of hydrogen-3 or carbon-14 per gram of medium used for liquid scintillation counting; and

(b) Not more than 0.05 microcurie of hydrogen-3 or carbon-14 per gram of animal tissue, averaged over the weight of the entire animal.

2. A licensee shall not dispose of tissue under paragraph (b) of subsection 1 in a manner that would permit its use either as food for humans or as feed for animals.

3. The licensee shall maintain records of the disposal of radioactive material described in this section until the Division terminates his or her license.

(Added to NAC by Bd. of Health, eff. 1-18-94)

NAC 459.362 Quantities of radioactive materials for signs, labels and signals; disposal of waste. (NRS 459.201) The following quantities must be used for the purposes of subsection 1 of NAC 459.1955:

Radioactive Material	Microcuries
Americium-241	0.01
Antimony-122	100
Antimony-124	10
Antimony-125	10
Arsenic-73	100
Arsenic-74	10
Arsenic-76	10
Arsenic-77	100
Barium-131	10
Barium-133	10
Barium-140	10
Bismuth-210	1

Radioactive Material	Microcuries
Bromine-82	10
Cadmium-109	10
Cadmium-115m	10
Cadmium-115	100
Calcium-45	10
Calcium-47	10
Carbon-14	100
Cerium-141	100
Cerium-143	100
Cerium-144	1
Cesium-131	1,000
Cesium-134m	100
Cesium-134	1
Cesium-135	10
Cesium-136	10
Cesium-137	10
Chlorine-36	10
Chlorine-38	10
Chromium-51	1,000
Cobalt-58m	10
Cobalt-58	10
Cobalt-60	1
Copper-64	100
Dysprosium-165	10
Dysprosium-166	100
Erbium-169	100
Erbium-171	100
Europium-152 (9.2 h)	100
Europium-152 (13 yr)	1
Europium-154	1
Europium-155	10
Fluorine-18	1,000
Gadolinium-153	10
Gadolinium-159	100
Gallium-72	10
Germanium-71	100
Gold-198	100
Gold-199	100
Hafnium-181	10
Holmium-166	100

Radioactive Material	Microcuries
Hydrogen-3	1,000
Indium-113m	100
Indium-114m	10
Indium-115m	100
Indium-115	10
Iodine-125	1
Iodine-126	1
Iodine-129	0.1
Iodine-131	1
Iodine-132	10
Iodine-133	1
Iodine-134	10
Iodine-135	10
Iridium-192	10
Iridium-194	100
Iron-55	100
Iron-59	10
Krypton-85	100
Krypton-87	10
Lanthanum-140	10
Lutetium-177	100
Manganese-52	10
Manganese-54	10
Manganese-56	10
Mercury-197m	100
Mercury-197	100
Mercury-203	10
Molybdenum-99	100
Neodymium-147	100
Neodymium-149	100
Nickel-59	100
Nickel-63	10
Nickel-65	100
Niobium-93m	10
Niobium-95	10
Niobium-97	10
Osmium-185	10
Osmium-191m	100
Osmium-191	100
Osmium-193	100

Radioactive Material	Microcuries
Palladium-103	100
Palladium-109	100
Phosphorus-32	10
Platinum-191	100
Platinum-193m	100
Platinum-193	100
Platinum-197m	100
Platinum-197	100
Plutonium-239	0.01
Polonium-210	0.1
Potassium-42	10
Praseodymium-142	100
Praseodymium-143	100
Promethium-147	10
Promethium-149	10
Radium-226	0.01
Rhenium-186	100
Rhenium-188	100
Rhodium-103m	100
Rhodium-105	100
Rubidium-86	10
Rubidium-87	10
Ruthenium-97	100
Ruthenium-103	10
Ruthenium-105	10
Ruthenium-106	1
Samarium-151	10
Samarium-153	100
Scandium-46	10
Scandium-47	100
Scandium-48	10
Selenium-75	10
Silicon-31	100
Silver-105	10
Silver-110m	1
Silver-111	100
Sodium-24	10
Strontium-85	10
Strontium-89	1
Strontium-90	0.1

Radioactive Material	Microcuries
Strontium-91	10
Strontium-92	10
Sulphur-35	100
Tantalum-182	10
Technetium-96	10
Technetium-97m	100
Technetium-97	100
Technetium-99m	100
Technetium-99	10
Tellurium-125m	10
Tellurium-127m	10
Tellurium-127	100
Tellurium-129m	10
Tellurium-129	100
Tellurium-131m	10
Tellurium-132	10
Terbium-160	10
Thallium-200	100
Thallium-201	100
Thallium-202	100
Thallium-204	10
Thorium (natural) [1]	100
Thulium-170	10
Thulium-171	10
Tin-113	10
Tin-125	10
Tungsten-181	10
Tungsten-185	10
Tungsten-187	100
Uranium (natural) [2]	100
Uranium-233	0.01
Uranium-234	0.01
Uranium-235	0.01
Vanadium-48	10
Xenon-131m	1,000
Xenon-133	100
Xenon-135	100
Ytterbium-175	100
Yttrium-90	10
Yttrium-91	10

Radioactive Material	Microcuries
Yttrium-92	100
Yttrium-93	100
Zinc-65	10
Zinc-69m	100
Zinc-69	1,000
Zirconium-93	10
Zirconium-95	10
Zirconium-97	10
Any alpha-emitting radionuclide not listed above or mixtures of alpha emitters of unknown composition	0.01
Any radionuclide other than alpha-emitting radionuclides, not listed above or mixtures of beta emitters of unknown composition	0.1

[1] Based on alpha disintegration rate of Th 232, Th 230, and their daughter products.

[2] Based on alpha disintegration rate of U 238, U 234, and U 235.

[Bd. of Health, Radiation Control Reg. Art. 4, Appendix B, eff. 2-28-80]—(NAC A 1-18-94)

NAC 459.3625 General requirements for preparation and retention of records. (NRS 459.030, 459.201)

1. Except as otherwise provided in subsection 5, each licensee and registrant shall use the units curie, rad, rem and roentgen, including multiples and subdivisions thereof, to prepare the records required by NAC 459.010 to 459.950, inclusive, and shall clearly indicate the units of all quantities entered on those records.

2. The licensee or registrant shall make a clear distinction among the quantities entered on the records required by NAC 459.010 to 459.950, inclusive, including, without limitation:

(a) Committed effective dose equivalent;

(b) Deep-dose equivalent;

(c) Lens dose equivalent;

(d) Shallow-dose equivalent; and

(e) Total effective dose equivalent.

3. The licensee may record, in parentheses following the unit measurements required pursuant to subsection 1, the equivalent quantities expressed as unit measurements pursuant to the International System of Units (SI).

4. A discontinuance or curtailment of the activities of a licensee or registrant does not relieve that licensee or registrant of the responsibility for retaining all records required by NAC 459.010 to 459.950, inclusive. A licensee or registrant may request the Division to retain such records. An acceptance of the records by the Division relieves the licensee or registrant of

subsequent responsibility only in respect to their retention as required by this section.

5. Each licensee or registrant shall use to prepare shipment manifests required pursuant to NAC 459.8231:

(a) The International System of Units (SI); or

(b) The International System of Units (SI) and the units set forth in subsection 1.

(Added to NAC by Bd. of Health, eff. 1-18-94; A by R084-98, 1-26-99; A by Dep't of Human Resources by R137-01, 5-30-2003; A by Bd. of Health by R149-07, 1-30-2008)

NAC 459.363 Authorized forms of records for purposes of legibility; safeguards. (NRS 459.201)

1. Each record required by NAC 459.010 to 459.950, inclusive, must be legible throughout the specified period of retention. The record must be:

(a) The original;

(b) A reproduced copy or a microform, if the copy or microform is authenticated by authorized personnel and, if microform is used, the microform is capable of producing a clear copy throughout the specified period of retention; or

(c) Stored in electronic media with the capability for producing legible, accurate and complete records during the specified period of retention.

2. A licensee or registrant shall maintain adequate safeguards to prevent tampering with and the loss of records.

(Added to NAC by Bd. of Health, eff. 1-18-94; A by R084-98, 1-26-99; R149-07, 1-30-2008)

NAC 459.3635 Records of program for protection against radiation. (NRS 459.201)

1. Each licensee and registrant shall maintain records of its program for protection against radiation required pursuant to NAC 459.321, including:

(a) The provisions of the program; and

(b) The results of audits and other reviews of the content and implementation of the program.

2. The licensee or registrant shall retain the records required by paragraph (a) of subsection 1 until the Division terminates each license or registration requiring the record. The licensee or registrant shall retain each record required by paragraph (b) of subsection 1 for at least 3 years after the record is made.

(Added to NAC by Bd. of Health, eff. 1-18-94)

NAC 459.3645 Records of surveys and calibrations. (NRS 459.201)

1. Each licensee and registrant shall maintain records showing the results of surveys and calibrations required pursuant to NAC 459.337 and 459.3585. The licensee or registrant shall retain each such record for at least 3 years after the record is made.

2. A licensee or registrant shall retain each of the following records until the Division authorizes their disposal:

(a) Records of the results of surveys used to determine the dose from external sources of radiation and, in the absence of or in combination with individual monitoring data, in the assessment of individual dose equivalents;

(b) Records of the results of measurements and calculations used to determine individual intakes of radioactive material and used in the assessment of internal doses;

(c) Records showing the results of sampling air and surveys and bioassays required pursuant to subparagraphs (1) and (2) of paragraph (c) of subsection 1 of NAC 459.349; and

(d) Records of the results of measurements and calculations used to evaluate the release of

radioactive effluents into the environment.

(Added to NAC by Bd. of Health, eff. 1-18-94)

NAC 459.365 Records of prior occupational doses. (NRS 459.201)

1. For each person who is likely to receive, in 1 year, an occupational dose requiring monitoring pursuant to NAC 459.339, the licensee or registrant shall:

(a) Determine the occupational dose received by that person during the current year; and

(b) Attempt to obtain the records of the lifetime cumulative occupational dose received by that person.

2. Before permitting a person to participate in a planned special exposure, the licensee or registrant shall determine:

(a) The internal and external doses received by that person from all previous planned special exposures;

(b) All doses in excess of the limits, including, without limitation, doses received during accidents and emergencies, received during the lifetime of the person; and

(c) All lifetime cumulative occupational doses.

3. To comply with the requirements of subsection 1, a licensee or registrant may:

(a) Accept, as a record of the occupational dose that the person received during the current year, a signed written statement from the person, or from his or her most recent employer for work involving exposure to radiation, that discloses the nature and the amount of any occupational dose that the person received during the current year.

(b) Accept, as the record of the lifetime cumulative dose received by a person, a current form regarding history of cumulative occupational exposure, signed by the person and countersigned by:

(1) An appropriate official of the most recent employer of the person for work involving exposure to radiation; or

(2) The current employer of the person, if the person is not employed by the licensee or registrant.

(c) Obtain reports regarding the dose equivalent of a person from his or her most recent employer for work involving exposure to radiation, or the current employer of the person if he or she is not employed by the licensee or registrant, by telephone, telegram, facsimile, electronic media or letter. The licensee or registrant shall request a written verification of the data if the authenticity of the transmitted report cannot be established.

4. A licensee or registrant shall record the history of exposure of each person, as required by subsection 1, on a form regarding history of cumulative occupational exposure, and shall include all the information required by that form. The form must show each period in which the person received occupational exposure to radiation or radioactive material and must be signed by that person. For each period for which the licensee or registrant obtains a report, the licensee or registrant shall use the dose shown in the report in preparing the form regarding history of cumulative occupational exposure. For any period in which the licensee or registrant does not obtain a report, the licensee or registrant shall place a notation on the form regarding history of cumulative occupational exposure indicating the periods for which data is not available.

5. Licensees and registrants are not required to reevaluate the separate dose equivalents received from sources of radiation outside the body and committed dose equivalents or intakes of radionuclides received from radioactive material taken into the body that are assessed before January 18, 1994. Histories of occupational exposure obtained and recorded on the form regarding history of cumulative occupational exposure before January 18, 1994, may be used in

the absence of specific information regarding the intake of radionuclides by the person.

6. If the licensee or registrant is unable to obtain a complete record of the current and previously accumulated occupational dose of a person, the licensee or registrant shall:

(a) In establishing administrative controls pursuant to subsection 6 of NAC 459.325 for the current year, assume that the allowable limits for the person are reduced by 1.25 rems for each quarter for which records were unavailable and the person was engaged in activities that could have resulted in occupational exposure; and

(b) Assume that the person is not available for planned special exposures.

7. The licensee or registrant shall retain the records on the form regarding history of cumulative occupational exposure until the Division terminates each license or registration requiring the records. The licensee or registrant shall retain each record used in preparing the form regarding history of cumulative occupational exposure for at least 3 years after that record is made.

(Added to NAC by Bd. of Health, eff. 1-18-94; A by R084-98, 1-26-99)

NAC 459.3655 Records of planned special exposures. (NRS 459.201)

1. For each planned special exposure authorized by a licensee or registrant pursuant to NAC 459.329, that licensee or registrant shall maintain records that describe:

(a) The exceptional circumstances requiring the use of a planned special exposure;

(b) The name of the management official who authorized the planned special exposure and a copy of the signed authorization;

(c) What actions were necessary;

(d) Why those actions were necessary;

(e) What precautions were taken to ensure that doses were maintained at a level which was as low as was reasonably achievable;

(f) What individual and collective doses were expected to result; and

(g) The doses actually received in the planned special exposure.

2. The licensee or registrant shall retain the records required pursuant to subsection 1 until the Division authorizes their disposal.

(Added to NAC by Bd. of Health, eff. 1-18-94)

NAC 459.3665 Records of results from individual monitoring. (NRS 459.030, 459.201)

1. Each licensee and registrant shall maintain records of doses received by all persons for whom monitoring is required pursuant to NAC 459.339, and records of doses received by persons during planned special exposures, accidents and emergency conditions. These records must include, when applicable:

(a) The deep-dose equivalent to the whole body, lens dose equivalent, shallow-dose equivalent to the skin and shallow-dose equivalent to the extremities;

(b) The estimated intake of radionuclides;

(c) The committed effective dose equivalent assigned to the intake of radionuclides;

(d) The specific information used to calculate the committed effective dose equivalent pursuant to NAC 459.3275 and, when required, pursuant to NAC 459.339;

(e) The total effective dose equivalent, when required pursuant to NAC 459.3255; and

(f) The total of the deep-dose equivalent and the committed dose to the organ receiving the highest total dose.

2. The licensee or registrant shall make entries of the records specified in this section at intervals not to exceed 1 year.

3. The licensee or registrant shall maintain the records required pursuant to this section on a record of occupational exposure for a monitoring period, in accordance with the instructions for that form provided by the Division.

4. The licensee or registrant shall maintain the records of doses to an embryo with the records of doses to the woman carrying the embryo who has declared her pregnancy. The records of the declaration of pregnancy, including the estimated date of conception, must also be maintained, but may be maintained separately from the records regarding doses.

5. The licensee or registrant shall retain each form or record required by this section until the Division authorizes its disposal.

(Added to NAC by Bd. of Health, eff. 1-18-94; A by Dep't of Human Resources by R137-01, 5-30-2003)

NAC 459.367 Records of dose to individual members of public. (NRS 459.201)

1. Each licensee and registrant shall maintain records sufficient to demonstrate compliance with the limits specified in NAC 459.335 for members of the public.

2. The licensee or registrant shall retain the records required by this section until the Division authorizes their disposal.

(Added to NAC by Bd. of Health, eff. 1-18-94)

NAC 459.3673 Records of disposal of waste. (NRS 459.201) Each licensee shall maintain records of the disposal of licensed radioactive materials made pursuant to the provisions of NAC 459.010 to 459.950, inclusive, including any burial authorized before April 27, 1984. The licensee shall retain the records required by this section until the Division terminates each license or registration requiring the records.

(Added to NAC by Bd. of Health, eff. 1-18-94; A by R084-98, 1-26-99; R149-07, 1-30-2008)

NAC 459.3675 Records of tests on entry control devices for very high radiation areas. (NRS 459.201)

1. Each licensee and registrant shall maintain records of tests made pursuant to NAC 459.345 on entry control devices for very high radiation areas. These records must include the date, time and results of each such test of function.

2. The licensee or registrant shall retain each record required by this section for at least 3 years after the record is made.

(Added to NAC by Bd. of Health, eff. 1-18-94)

NAC 459.368 Notice and reports to persons exposed to radiation or radioactive material. (NRS 459.070, 459.201)

1. Requirements for notification and reports to persons of exposure to radiation or radioactive material are specified in NAC 459.786.

2. When a licensee or registrant is required by NAC 459.371 or 459.3715 to report to the Division any exposure of an identified occupationally exposed person or an identified member of the public to radiation or radioactive material, the licensee or registrant shall also notify the person or member of the public who was exposed. The notice must be transmitted at a time not later than the transmittal to the Division, and the notice must comply with the provisions of subsection 1 of NAC 459.786.

[Bd. of Health, Radiation Control Reg. §§ 4.5.6 & 4.5.6.1, eff. 2-28-80]—(NAC A 1-18-94; R185-08, 5-7-2010)

NAC 459.369 Requirements for report of lost, stolen or missing licensed radioactive material or radiation machines. (NRS 459.201)

1. Each licensee and registrant shall report to the Division by telephone:

(a) Any lost, stolen or missing licensed radioactive material in an aggregate quantity which is equal to or greater than 1,000 times the quantity specified in Appendix C, if it appears to the licensee that an exposure could result to persons in unrestricted areas. The report must be made immediately after the occurrence becomes known to the licensee.

(b) Any lost, stolen or missing licensed radioactive material in an aggregate quantity which is greater than 10 times the quantity specified in Appendix C within 30 days after the occurrence becomes known to the licensee. The report is not required if the material is located or otherwise recovered by the licensee or registrant within the specified 30-day period.

(c) A lost, stolen or missing radiation machine. The report must be made immediately after the occurrence becomes known to the registrant.

2. Each licensee and registrant required to make a report pursuant to subsection 1 shall, within 30 days after making the report by telephone, file a written report with the Division setting forth the following information:

(a) A description of the licensed or registered source of radiation that is lost, stolen or missing, including:

(1) For licensed radioactive material, the kind, quantity, and chemical and physical form of the material; and

(2) For a radiation machine, the manufacturer and model and serial number of the machine and the type and maximum energy of radiation emitted from the machine.

(b) A description of the circumstances under which the loss or theft occurred.

(c) A statement of disposition, or probable disposition, of the licensed or registered source of radiation.

(d) Exposures of persons to radiation emitted from the licensed or registered source of radiation, the circumstances under which the exposures occurred and the possible total effective dose equivalent to persons in unrestricted areas.

(e) Actions that have been taken, or will be taken, to recover the source of radiation.

(f) Procedures or measures that have been, or will be, adopted to ensure against a recurrence of the loss or theft of licensed or registered sources of radiation.

3. After filing the report required pursuant to subsection 2, the licensee or registrant shall, within 30 days after learning of any additional substantive information regarding the loss or theft, file an additional written report with the Division.

4. The licensee or registrant shall prepare any report filed with the Division pursuant to this section so that the names of persons who may have received exposure to radiation are stated in a separate and detachable portion of the report.

(Added to NAC by Bd. of Health, eff. 1-18-94)

NAC 459.3695 Report of certain incidents. (NRS 459.030, 459.070, 459.201)

1. Each licensee and registrant shall immediately report to the Division each event involving a source of radiation possessed by the licensee or registrant that may have caused, or threatens to cause:

(a) A person to receive:

(1) A total effective dose equivalent of 25 rems (250 millisieverts) or more;

(2) A lens dose equivalent of 75 rems (750 millisieverts) or more; or

(3) A shallow-dose equivalent to the skin or extremities or a total organ dose equivalent of 250 rads (2.5 grays) or more.

(b) The release of radioactive material, inside or outside a restricted area, in a manner in

which, had a person been present for 24 hours, the person could have received an intake of radiation that is five times the annual limit on intake for occupational exposure. The provisions of this paragraph do not apply to an area where personnel are not normally stationed during routine operations.

2. Except as otherwise provided in NAC 459.369, each licensee and registrant shall, within 24 hours after discovery, report to the Division each event involving the loss of control of a licensed or registered source of radiation possessed by the licensee or registrant that may have caused, or threatens to cause:

(a) A person to receive, in a period of 24 hours:

(1) A total effective dose equivalent exceeding 5 rems (50 millisieverts);

(2) A lens dose equivalent exceeding 15 rems (150 millisieverts); or

(3) A shallow-dose equivalent to the skin or extremities or a total organ dose equivalent exceeding 50 rems (500 millisieverts).

(b) The release of radioactive material, inside or outside a restricted area, in a manner in which, had a person been present for 24 hours, the person could have received an intake of radiation that is more than the annual limit on intake for occupational exposure. The provisions of this paragraph do not apply to an area where personnel are not normally stationed during routine operations.

3. The licensee or registrant shall prepare each report filed with the Division pursuant to this section so that the names of persons who have received exposure are stated in a separate and detachable portion of the report.

4. Licensees or registrants shall make the reports required by subsections 1 and 2 to the Division by telephone, telegram, mailgram or facsimile.

5. The provisions of this section do not apply to doses that result from planned special exposures, if such doses are within the limits for planned special exposures and are reported pursuant to NAC 459.371.

(Added to NAC by Bd. of Health, eff. 1-18-94; A by R084-98, 1-26-99; A by Dep't of Human Resources by R137-01, 5-30-2003)

NAC 459.371 Submission of written reports for certain occurrences; contents of reports. (NRS 459.030, 459.070, 459.201)

1. In addition to the notification required by NAC 459.3695, each licensee and registrant shall submit a written report to the Division within 30 days after learning of any of the following occurrences:

(a) Incidents for which notification is required pursuant to NAC 459.3695.

(b) Doses in excess of:

(1) The limits for an occupational dose for an adult specified in NAC 459.325;

(2) The limits for an occupational dose for a minor specified in NAC 459.331;

(3) The limits for an embryo of a woman who has declared her pregnancy specified in NAC 459.333;

(4) The limits for a member of the public specified in NAC 459.335;

(5) Any applicable limits set forth in the license or registration; or

(6) The constraints on air emissions of radioactive material, excluding radon 222 and its decay products, specified in subsection 2 of NAC 459.321.

(c) Levels of radiation or concentrations of radioactive material in:

(1) A restricted area in excess of any applicable limits set forth in the license or registration; or

(2) An unrestricted area in excess of 10 times the applicable limits set forth in NAC 459.010 to 459.950, inclusive, or in the license or registration.

(d) For licensees subject to the provisions of the generally applicable environmental standards for radiation of the United States Environmental Protection Agency set forth in 40 C.F.R. Part 190, levels of radiation or releases of radioactive material in excess of those standards, or of conditions set forth in the license related to those standards.

2. Each report required pursuant to subsection 1 must describe the extent of exposure of persons to radiation and radioactive material, including, as appropriate:

(a) Estimates of the dose of each person;

(b) The levels of radiation and concentrations of radioactive material involved;

(c) The cause of the elevated exposures, dose rates or concentrations; and

(d) Corrective steps taken or planned to ensure against a recurrence, including, without limitation, the schedule for achieving conformance with applicable limits, constraints on air emissions of radioactive material, excluding radon 222 and its decay products, specified in subsection 2 of NAC 459.321, generally applicable environmental standards for radiation of the United States Environmental Protection Agency and associated conditions set forth in the license or registration.

3. Each report filed pursuant to this section must include, for each person exposed, his or her name, social security number and date of birth. With respect to reports of exposure to an embryo, the information must relate to the woman carrying the embryo. The report must be prepared so that the information required by this subsection is stated in a separate and detachable portion of the report.

(Added to NAC by Bd. of Health, eff. 1-18-94; A by R084-98, 1-26-99; A by Dep't of Human Resources by R137-01, 5-30-2003; A by Bd. of Health by R149-07, 1-30-2008)

NAC 459.3715 Submission of written reports after planned special exposures. (NRS 459.201) Each licensee and registrant shall submit a written report to the Division within 30 days following any planned special exposure conducted in accordance with NAC 459.329 informing the Division that a planned special exposure was conducted, and including the date the planned special exposure occurred and the information required by NAC 459.3655.

(Added to NAC by Bd. of Health, eff. 1-18-94)

NAC 459.373 Additional reporting requirements. (NRS 459.201) In addition to complying with any other reporting requirements specified in NAC 459.010 to 459.950, inclusive, a licensee shall comply with the following reporting requirements:

1. Each licensee shall notify the Division as soon as possible, but not later than 4 hours, after the discovery of an event that prevents immediate protective actions to be taken that are necessary to avoid exposure to radiation or radioactive materials that could exceed the limits specified in NAC 459.010 to 459.950, inclusive.

2. Each licensee shall notify the Division within 24 hours after the discovery of any of the following events involving licensed radioactive material:

(a) An unplanned event causing radioactive contamination that:

(1) Requires access to the contaminated area by workers or members of the public to be restricted for more than 24 hours by imposing additional radiological controls or by prohibiting entry into the area, if such a restriction is imposed for any reason other than to allow isotopes with a half-life of less than 24 hours to decay in storage before decontamination; and

(2) Involves a quantity of radioactive material which is greater than five times the lowest annual limit on intake specified in Appendix B for that material.

(b) An event in which equipment is disabled or fails to function as designed if:

(1) The equipment is required pursuant to NAC 459.010 to 459.950, inclusive, or as a condition of a license, to prevent releases of or exposure to radioactive materials exceeding the limits specified in NAC 459.010 to 459.950, inclusive, or to mitigate the consequences of an accident;

(2) The equipment is required to be available and operable when it is disabled or fails to function; and

(3) Other equipment is not available and operable to perform the required safety function.

(c) An event that requires unplanned medical treatment at a medical facility for a person who has spreadable radioactive contamination on his or her clothing or body.

(d) An unplanned fire or explosion damaging any licensed radioactive material or any device, container or equipment containing licensed radioactive material if:

(1) The quantity of radioactive material involved is greater than five times the lowest annual limit on intake specified in Appendix B for that radioactive material; and

(2) The damage affects the integrity of the licensed radioactive material or its container.

3. Reports made by a licensee pursuant to this section must be made as follows:

(a) A licensee shall make the reports required by subsections 1 and 2 by telephone. To the extent that the information is available at the time of notification by telephone, the information provided in these reports must include, without limitation:

(1) The name and telephone number of the caller;

(2) A description of the event, including, without limitation, the date and time of the event;

(3) The exact location of the event;

(4) The isotopes, quantities and chemical and physical form of the licensed radioactive material involved; and

(5) Any data regarding the exposure of persons to radiation because of the event.

(b) Except as otherwise provided in paragraph (c), each licensee who makes a report by telephone shall submit a written report to the Division within 30 days after the report by telephone is made. The written report must contain:

(1) A description of the event, including, without limitation, the probable cause of the event and the manufacturer and model number of any equipment that failed or malfunctioned;

(2) The exact location of the event;

(3) The isotopes, quantities and chemical and physical form of the licensed radioactive material involved;

(4) The date and time of the event;

(5) Any corrective actions taken or planned regarding the event;

(6) The results of any evaluations or assessments regarding the event; and

(7) The extent of any exposure of persons to radiation or to radioactive materials because of the event, without identifying those persons by name.

(c) A licensee is not required to comply with the provisions of paragraph (b) if a report submitted pursuant to NAC 459.010 to 459.950, inclusive, contains all the information required by paragraph (b).

(Added to NAC by Bd. of Health, eff. 1-18-94; A by R084-98, 1-26-99; R149-07, 1-30-2008)

NAC 459.374 Notice of intent to vacate premises. (NRS 459.201) Each specific licensee must, no less than 30 days before vacating or relinquishing possession or control of

premises which may have been contaminated with radioactive material as a result of his or her activities, notify the Division in writing of intent to vacate. When deemed necessary by the Division, the licensee shall decontaminate the premises in the manner specified by the Division.

[Bd. of Health, Radiation Control Reg. § 4.5.5, eff. 2-28-80]

Radiation Safety Requirements for Analytical X-Ray Equipment

NAC 459.640 Definitions. As used in NAC 459.640 to 459.664, inclusive, unless the context otherwise requires, the words and terms defined in NAC 459.642 to 459.654, inclusive, have the meanings ascribed to them in those sections.

(Supplied in codification)

NAC 459.642 "Analytical X-ray equipment" defined. (NRS 459.201) "Analytical X-ray equipment" means equipment used for X-ray diffraction or fluorescence analysis.

[Bd. of Health, Radiation Control Reg. § 8.2.1, eff. 2-28-80]

NAC 459.644 "Analytical X-ray system" defined. (NRS 459.201) "Analytical X-ray system" means a group of local and remote components utilizing X rays to determine the elemental composition or to examine the microstructure of materials.

[Bd. of Health, Radiation Control Reg. § 8.2.2, eff. 2-28-80]

NAC 459.646 "Fail-safe characteristics" defined. (NRS 459.201) "Fail-safe characteristics" means design features which cause beam port shutters to close or which otherwise prevent emergence of the primary beam upon the failure of a safety or warning device.

[Bd. of Health, Radiation Control Reg. § 8.2.3, eff. 2-28-80]

NAC 459.648 "Local components" defined. (NRS 459.201)

1. "Local components" means part of an analytical X-ray system and includes areas exposed to X rays, such as radiation source housings, port and shutter assemblies, collimators, sample holders, cameras, goniometers, detectors and shielding.

2. The term does not include power supplies, transformers, amplifiers, readout devices and control panels.

[Bd. of Health, Radiation Control Reg. § 8.2.4, eff. 2-28-80]

NAC 459.650 "Normal operating procedures" defined. (NRS 459.030, 459.201) "Normal operating procedures" means operating procedures necessary to accomplish the X-ray procedure being performed, including, without limitation, positioning of the equipment and the object being examined, alignment of the equipment, routine maintenance of the equipment and the procedures for recording data relating to radiation safety.

[Bd. of Health, Radiation Control Reg. § 8.2.5, eff. 2-28-80]—(NAC A by Dep't of Human Resources by R137-01, 5-30-2003)

NAC 459.652 "Open-beam configuration" defined. (NRS 459.201) "Open-beam configuration" means an analytical X-ray system in which a person could accidentally place some part of his or her body in the primary beam path during a normal operation.

[Bd. of Health, Radiation Control Reg. § 8.2.6, eff. 2-28-80]

NAC 459.654 "Primary beam" defined. (NRS 459.201) "Primary beam" means ionizing radiation which passes through an aperture of the source housing by a direct path from the X-ray tube or a radioactive source located in the radiation source housing.

[Bd. of Health, Radiation Control Reg. § 8.2.7, eff. 2-28-80]

NAC 459.656 Scope. (NRS 459.030, 459.201) The provisions of NAC 459.640 to 459.664, inclusive, establish requirements, binding upon registrants, for use of analytical X-ray equipment. These requirements are in addition to, and not in substitution for, other applicable requirements of NAC 459.010 to 459.794, inclusive.

[Bd. of Health, Radiation Control Reg. § 8.1, eff. 2-28-80]—(NAC A by Dep't of Human Resources by R137-01, 5-30-2003)

NAC 459.658 Equipment requirements. (NRS 459.201)

1. A safety device which prevents the entry of any portion of a person's body into the primary X-ray beam path or which causes the beam to be shut off upon entry into its path must be provided on all open-beam configurations. A registrant or licensee may apply to the Division for an exemption from the requirements of a safety device. Such an application must include:

(a) A description of the various safety devices that have been evaluated;

(b) The reason each of these devices cannot be used; and

(c) A description of the alternative methods that will be employed to minimize the possibility of an accidental exposure, including procedures to ensure that operators and others in the area will be informed of the absence of safety devices.

2. Open-beam configuration must be provided with a readily discernible indication of:

(a) X-ray tube status whether on or off, located near the radiation source housing if the primary beam is controlled in this matter; or

(b) Shutter status whether open or closed, located near each port on the radiation source housing if the primary beam is controlled in this manner.

3. Warning devices must be so labeled that their purpose is easily identified. On equipment installed after February 28, 1980, warning devices must have fail-safe characteristics.

4. Unused ports on radiation source housings must be secured in the closed position in a manner which will prevent casual openings.

5. All analytical X-ray equipment must be labeled with a readily discernible sign bearing the radiation caution symbol and the words:

(a) "CAUTION - HIGH INTENSITY X-RAY BEAM," or words having a similar intent, on the X-ray source housing; and

(b) "CAUTION RADIATION - THIS EQUIPMENT PRODUCES RADIATION WHEN ENERGIZED," or words having a similar intent, near any switch that energizes an X-ray tube if the radiation source is an X-ray tube; or

(c) "CAUTION - RADIOACTIVE MATERIAL," or words having a similar intent, on the source housing if the radiation source is a radionuclide.

6. On open-beam configurations installed after February 28, 1980, each port on the radiation source housing must be equipped with a shutter that cannot be opened unless a collimator or a coupling has been connected to the port.

7. An easily visible warning light labeled with the words "X RAY ON," or words having a similar intent, must be located:

(a) Near any switch that energizes an X-ray tube and be illuminated only when the tube is energized; or

(b) In the case of a radioactive source, near any switch that opens a housing shutter and be illuminated only when the shutter is open.

8. On equipment installed after February 28, 1980, warning lights must have fail-safe characteristics.

9. Each X-ray tube housing must be constructed so that with all shutters closed the leakage radiation measured at a distance of 5 cm from its surface is not capable of producing a dose in excess of 2.5 mrem in 1 hour at any specified tube rating. If radioactive sources are used, corresponding dose limits must not exceed 2 mrem per hour.

10. Each X-ray generator must be supplied with a protective cabinet which limits leakage radiation measured at a distance of 5 cm from its surface so that it is not capable of producing a dose in excess of 0.25 mrem in 1 hour.

[Bd. of Health, Radiation Control Reg. §§ 8.3-8.3.8, eff. 2-28-80]

NAC 459.660 Area requirements. (NRS 459.201)

1. The local components of an analytical X-ray system must be so located and arranged to include sufficient shielding or access control so that no radiation levels exist in any area surrounding the local component group which could result in a dose to a person present therein in excess of the dose limits given in NAC 459.335. For systems utilizing X-ray tubes, these levels must be met at any specified tube rating.

2. Radiation surveys, as required by NAC 459.337, of all analytical X-ray systems sufficient to show compliance with subsection 1 must be performed:

(a) Upon installation of the equipment and at least every 12 months thereafter;

(b) Following any change in the initial arrangement, number or type of local components in the system;

(c) Following any maintenance requiring the disassembly or removal of a local component in the system;

(d) During the performance of maintenance and alignment procedures if the procedures require the presence of a primary X-ray beam when any local component in the system is disassembled or removed;

(e) Any time a visual inspection of the local components in the system reveals an abnormal condition; and

(f) Whenever personnel monitoring devices show a significant increase over the previous monitoring period or when the readings are approaching the radiation dose limits specified in NAC 459.320 to 459.374, inclusive.

3. Radiation survey measurements are not required if a registrant or licensee can demonstrate compliance with subsection 1 to the satisfaction of the Division in some other manner.

4. Each area or room containing analytical X-ray equipment must be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words "CAUTION - X-RAY EQUIPMENT," or words having a similar intent.

[Bd. of Health, Radiation Control Reg. §§ 8.4-8.4.3, eff. 2-28-80]—(NAC A 1-18-94)

NAC 459.662 Operating requirements. (NRS 459.201)

1. Normal operating procedures must be written and made available to all workers on analytical X-ray equipment. No person may operate analytical X-ray equipment in any manner other than that specified in the procedures unless he or she has obtained written approval of the person responsible for radiation safety.

2. No person may bypass a safety device unless he or she has obtained the approval of the person responsible for radiation safety. Such an approval must be for a specified period. When a safety device has been bypassed, a readily discernible sign bearing the words "SAFETY DEVICE NOT WORKING," or words having a similar meaning, must be placed on the radiation source housing and the control panel.

[Bd. of Health, Radiation Control Reg. §§ 8.5-8.5.2, eff. 2-28-80]

NAC 459.664 Personnel requirements. (NRS 459.201)

1. No person may operate or maintain analytical X-ray equipment unless he or she has received instruction in and demonstrated competence with regard to:

(a) Identification of radiation hazards associated with the use of the equipment;

(b) Significance of the various radiation warning and safety devices incorporated into the equipment, or the reasons they have not been installed on certain pieces of equipment and the

extra precautions required in such cases;

(c) Proper operating procedures for the equipment;

(d) Symptoms of an acute localized exposure; and

(e) Proper procedures for reporting an actual or suspected exposure.

2. Each licensee or registrant shall maintain, for inspection by the Division, records of training which demonstrate that the requirements of subsection 1 have been met.

3. Finger or wrist dosimetric devices must be provided to and used by:

(a) Workers on analytical X-ray equipment having an open-beam configuration and not equipped with a safety device; and

(b) Personnel maintaining analytical X-ray equipment if the maintenance procedures require the presence of a primary X-ray beam when any local component in the analytical X-ray system is disassembled or removed.

4. Reported dose values may not be used for the purpose of determining compliance with NAC 459.325 unless evaluated by a qualified expert.

[Bd. of Health, Radiation Control Reg. §§ 8.6-8.6.2.2, eff. 2-28-80]—(NAC A 1-18-94)