

# Environmental Health and Safety Radiation Safety Manual

## I. RADIATION SAFETY

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### I. [Purpose and Scope:](#)

- A. This manual provides radiation protection guidelines for meeting the requirements of the university's broad-scope byproduct materials license so that the beneficial use of ionizing radiation sources at The University of Wyoming will not endanger the health and safety of workers, students or the general public.
- B. This Radiation Safety Manual applies only to sources of ionizing radiation, such as alpha particles, beta particles, neutrons, gamma rays, X-rays, high-energy electrons and protons. It does not cover non-ionizing sources, such as radio- or microwaves, electromagnetic fields, lasers, or visible, infrared, or ultraviolet light.

### II. [Organization and Responsibilities:](#)

#### A. [Radiation Safety Committee](#)

- 1. The Radiation Safety Committee is a standing University of Wyoming (University) Administrative Committee, with members appointed, and a chairperson designated, by the president. The composition, voting membership, quorum and general duties are described in University Regulation 2, Revision 6, paragraph h, and in the University [Radiation Safety Committee Control Functions and Administrative Procedures](#) manual, available in the Environmental Health and Safety main office. A list of the current members of the Radiation Safety Committee appears in [Appendix A](#). The cognizant, vice president is the Vice President for Finance.
- 2. The Radiation Safety Committee is responsible for establishing and administering the University's policies and procedures for all uses of ionizing radiation (radioactive materials and radiation generating machines) in teaching, research and extension service at University facilities and operating sites, within the restrictions imposed by the U.S. Nuclear Regulatory Commission (NRC) and/or state agencies. The duties and responsibilities of the Radiation Safety Committee shall include, but should not be limited to, the following:
  - a. Meet as often as necessary to conduct business, but not less than quarterly
  - b. Conduct periodic reviews and audits of the radiation safety program, and devote sufficient time with the RSO and Environmental Health and Safety (EHS) staff reviewing records, reports from the RSO, results of NRC inspections,

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written safety procedures, and observing audits performed by the RSO and the EHS staff to ensure the adequacy of the University's management control systems.

- c. Establish criteria for evaluating potential users and uses of ionizing radiation, radioactive materials usage and storage areas and radioactive waste storage areas.
  - d. Develop procedures and criteria for training and testing each category of worker, and for evaluating the effectiveness of the training program.
  - e. Maintain records of the committee's proceedings and safety evaluations of proposed users and uses of ionizing radiation
  - f. Periodically review and update the Radiation Safety Manual and distribute other radiation safety information as necessary to ensure proper program implementation, good health physics practices and compliance with applicable regulations.
3. The committee may delegate some of its functions to the RSO; EHS staff or to subcommittees, but is responsible for the ultimate performance of these functions.

### B. [Radiation Safety Officer](#)

1. The Radiation Safety Officer (RSO) shall be a person having specialized training and experience in radiation protection (Health Physics). The primary function of the RSO is to provide guidance and advice to the Radiation Safety Committee and the radiation users on all matters pertaining to the safe use of radiation sources. The duties and responsibilities of the RSO or RSO staff are:
  - a. Surveillance of overall activities involving ionizing radiation, including routine monitoring and special surveys of all areas in which radioactive materials and radiation devices are used.
  - b. Determine compliance with rules and regulations, license conditions, and the conditions of product approvals specified by the Radiation Safety Committee.
  - c. Monitor and maintain absolute and other special filter systems associated with the use, storage, or disposal of radioactive material.
  - d. Furnish consulting services on all aspects of radiation

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- protection to personnel at all levels of responsibility.
- e. Approve all acquisitions by the institution of ionizing radiation sources. Order, receive, deliver, open and leak test as necessary all shipments of radioactive material arriving at the institution and package, ship all radioactive material leaving the institution in accordance with NRC and DOT regulations.
  - f. Distribute and process area and personnel monitors (dosimeters), determine the need for and evaluation of bioassays, monitor personnel exposure and bioassay records and notify individuals and their supervisors of exposures approaching University action levels and recommended appropriate remedial action.
  - g. Conduct training programs and otherwise instruct personnel in the proper procedures for the use of radioactive material and radiation devices prior to use, at periodic intervals (refresher training) and as required by changes in procedures, equipment and regulations, etc.
  - h. Supervise and coordinate the radioactive waste disposal program, including effluent monitoring and maintenance of waste storage and disposal records.
  - i. Store radioactive materials not in current use.
  - j. Perform leak tests on sealed sources as required.
  - k. Calibrate hand-held radiation survey instruments at least annually.
  - l. Maintain an inventory of all radiation devices and radioisotopes at the institution. Limit the quantity of Radionuclides at the institution to the amounts authorized by the NRC license.
  - m. Immediately terminate, without the need of prior approval from senior officials or the offending investigator or department, any activity involving ionizing radiation that is found to be a threat to health or property, or in violation of applicable regulations.
  - n. Supervise decontamination and recovery operations.
  - o. Maintain other records not specifically designated above, as required by 10 CFR 30.51 or 29 CFR 1910.1096.
2. The RSO serves as a voting member of the Radiation Safety Committee and performs the duties delegated by the committee, e.g. the routine auditing of the activities of radiation users to assure

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compliance with license conditions and with state and federal regulations.

### C. [Radioactive Materials or Radiation Users:](#)

1. Radioactive Materials or Radiation Users are those persons who are authorized by the Radiation Safety Committee to utilize radiation sources at University facilities. Training requirements for each category are listed in section III-C.
2. **Principal Users** are persons with faculty or Principal Investigator status, and sufficient training, experience and authority to assume full responsibility for programs involving radiation sources. A principal user must ensure that training, work conditions and equipment are all adequate to provide safety and health protection for all workers in the group. Principal users are also responsible for assuring that all uses of radiation sources by subordinates are conducted according to applicable laws and procedures.
3. **Independent Users** are persons with sufficient training and experience to use radiation sources safely without direct supervision, but who lack the authority to assume full responsibility for a radiation program (e.g. technicians and graduate students).
4. **Supervised Users** are persons who must work with radiation sources under the direct supervision of a principal or independent user. A user in this category must follow approved procedures and must not work alone or attempt to supervise others. All supervised and independent users must be responsible to a principal user who, in turn, is responsible to the Radiation Safety Committee.
5. **Minors Under 18 Years of Age** are restricted from radiation workplaces unless on a conducted tour or in training. Minors must be authorized by the RSO, must wear appropriate monitoring equipment, and will be permitted only under conditions presenting high assurance of maintaining a resulting annual dose equivalent of less than ten percent (10%) of the adult annual equivalent dose limits in [Table 1](#).

### III. [Exposure Control and Emergency Procedures](#)

#### A. [Equivalent Dose Limits:](#)

1. The limits for occupational exposure to radioactive materials at UW are listed in [Table 1](#) below. The dose limits for radiation producing devices (x-rays) are covered in Appendix G. However, it is UW policy

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to use procedures and engineering controls based upon practical, sound radiation protection principles to achieve occupational doses and doses to the public that are as low as reasonably achievable (ALARA). If an employee's dose exceeds the ALARA limits for the month (column 3) they are requested to review procedures for ways to reduce future exposures. If occupational doses exceed the monthly average of the allowable limits (column 2) the Radiation Safety Officer will conduct an investigation into the probable cause of the dose, possible exposure to non-monitored personnel or the public, and methods to reduce future exposures.

[Table 1](#)  
**Occupational Effective Dose Equivalent Limits (from 10 CFR 20.1201)  
and University of Wyoming monthly ALARA limits**

<u>Body Part</u>	<u>Col. 1 Annual Dose</u>	<u>Col.2 Monthly Average</u>	<u>Col.3 ALARA Limits</u>
<b>_____ ADULTS:</b>			
Total effective dose equivalent (TEDE) to whole body	5 rems	416 mrems	10 mrem
Sum of deep-dose equivalent and committed dose equivalent to any individual organ or tissue (other than the lens of the eye)	50 rems	4.16 rems	100 mrem
Eye dose equivalent	15 rems	1.25 rems	30 mrem
Shallow dose equivalent to skin or any extremity	50 rems	4.16 rems	100 mrem
<b>_____ MINORS (under 18):</b>			
Annual effective dose equivalent limits are 10 percent of the adult limits listed above			
<b>_____ DECLARED PREGNANT WOMAN</b>			
Exposure to embryo/fetus due to exposure of declared pregnant woman	500 mrem	50 mrem	1 mrem

2. Declared Pregnant Women:

- a. The exposure to an embryo/fetus during the entire gestation period, due to the occupational exposure of a declared pregnant woman, shall not exceed 0.5 rem. Exposure should not vary substantially above an average uniform monthly exposure rate so as to satisfy this limit (approximately .05

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rem/month).

### 3. Controlled Access to the Public:

#### a. Non-controlled area:

Members of the general public shall not receive equivalent doses greater than 2 millirem in any one hour or greater than 100 millirem in any one-year. Radiation levels in areas accessible to visitors shall be kept to a minimum so that the total visitor exposure during all visits in any twelve consecutive months is less than 100 millirem.

#### b. Controlled area:

Any area where equivalent doses may exceed 100 millirem in one year or 2 millirem in one hour, or areas in which combined quantities of radioactive materials greater than or equal to ten times the activity for the radionuclide from column 3, [Appendix C](#) are used or stored are designated as "controlled areas". Transportation of radioactive materials with activities greater than these limits into or through non-controlled areas should be avoided when practical. When not occupied by authorized personnel, the area must be locked or otherwise made inaccessible (see section III.C).

### B. [Personal Monitoring:](#)

#### 1. Personal monitoring is required by:

- a. Adult workers likely to receive doses from external sources in excess of ten percent (10%) of their respective limits;
- b. Minors who are likely to receive an annual deep dose equivalent of 0.1 rem, or 10% of their limits for eye dose or shallow dose to the skin;
- c. Declared pregnant women who are likely to receive a dose of 0.1 rem distributed evenly over the gestation period.
- d. Individuals entering a high radiation or very high radiation area.

#### 2. Personal monitoring devices are provided by EHS. Dosimeters are usually exchanged monthly, but may be used for longer wear periods as evaluated by the RSO. The new badges are sent to a contact person for distribution. The previous month's badges are returned to EHS, where they are sent to a contractor who is certified by the

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National Voluntary Laboratory Accreditation Program to read the badges and report the exposure back to the University.

3. Dosimeters should be stored away from excessive heat and in a “background” radiation area when not being used. Dosimeters subject to abuse are to be recalibrated.
4. Direct reading dosimeters will be calibrated by the RSO. Pocket dosimeter exposure records should be kept in duplicate. The original copy is returned to EHS on a monthly basis where exposures will be incorporated into the permanent exposure records as appropriate.

C. [Internal Exposure Monitoring \(bioassay, see NRC Regulatory Guide 8.9\):](#)

1. Internal exposure monitoring is required for adults likely to receive in 1 year an intake in excess of 10% of the applicable Annual Limit of Intake (ALI) for ingestion and inhalation, and minors or declared pregnant women likely to receive in 1 year a committed effective dose equivalent in excess of 50 mrem. Use of respiratory protection must be approved by EHS. When such protection is required, bioassay measurements will be performed to verify the effectiveness of the respirators.

2. Urine Samples:

Individuals using unsealed radioisotopes in millicurie amounts per experiment will be evaluated by EHS as to whether they will be required to submit urine samples. Workers who are required to do so shall submit samples on a regular basis, the schedule determined by the workplace activity. Individuals in workplaces with non-routine usage shall submit the urine samples within one week of the usage. Control urine samples taken before handling the radioisotope(s) should be submitted for comparison. Environmental Health and Safety will supply urine collection bottles, pick up urine samples and process the samples for the isotope(s) of interest.

D. [Thyroid Scans \(See NRC Regulatory Guide 8.20\):](#)

1. Thyroid scans will be conducted for personnel working with radioactive  $I^{125}$  or  $I^{131}$  and wearing respirators if for any reason the  $I^{125}$  or  $I^{131}$  concentration and/or the duration of exposure are unknown.
2. Except as specified in the previous paragraph, routine bioassay is required for individuals who, during three consecutive months, handle quantities of radioactive iodine exceeding the activities from

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[Table 2](#). Others individuals working within a few meters and in the same room should also participate in bioassay.

3. Types of bioassays to be performed
  - a. **Baseline:** (Pre-employment or pre-operational) Within two weeks prior to beginning work with amounts exceeding those set forth in [Table 2](#).
  - b. **Routine:** At frequencies specified in item 4.
  - c. **Post-operational and other terminal conditions:** A bioassay is required within the last two weeks of possible exposure to  $I^{125}$  or  $I^{131}$  when the worker is terminating activities with potential exposure to these radionuclides.
  - d. **Diagnostic:** Follow-up bioassay is required within two weeks of any measurement exceeding levels given as action points in Regulatory Guide 8.20 in order to confirm the initial result and, in the case of a single intake, to allow an estimate of the effective half-life of radioiodine in the thyroid.

[Table 2](#)  
**Activity Levels Above Which Bioassay for  $I^{125}$  or  $I^{131}$  is Necessary**  
 (from USNRC Regulatory Guide 8.20, as amended by 10 CFR 20)

<u>Types of Operation</u>	Activity in Unsealed Form	
	<u>Volatile or Dispersible</u>	<u>Bound to Non-volatile Agent (or RIA Kits)</u>
Process in open room or bench, with possible escape of iodine from process vessels	1 mCi	10 mCi
Processes with possible escape of iodine carried out within a fume hood of adequate design, face velocity and performance reliability	10 mCi	100 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	100 mCi	1000 mCi

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4. Frequency:
  - a. Initial Routine. A bioassay is required between 6 and 72 hours following initial possible exposure to  $I^{125}$  or  $I^{131}$  where bioassay is required as set forth in items 1 or 2, and every two weeks thereafter as long as conditions described in items 1 or 2 exist. When work with radioactive iodine is less frequent than every two weeks a bioassay is required between 6 and 72 hours of the end of the work period when radioactive iodine is handled.
  - b. After three months: When a periodic measurement frequency has been selected in accordance with 4.a. the bioassay may be changed to quarterly if, after three months, all of the following conditions are met:
    - (1) The average thyroid burden for each individual assayed in the working area was less than 0.12  $\mu\text{Ci}$  of  $I^{125}$ , less than 0.04  $\mu\text{Ci}$  of  $I^{131}$ , and less than the corresponding proportionate amount of a mixture of these nuclides during an initial three month period.
    - (2) The quarterly average air concentration of radioiodine ( $\mu\text{Ci}/\text{ml}$ ) in air breathed by any worker (as obtained when measurements of radioiodine concentrations in air are required) does not exceed 25% of the derived air concentration (DAC) values in Appendix B to 10CFR20. When  $I^{131}$  and  $I^{125}$  are both present the amounts shall be weighted proportionally.
    - (3) The working conditions during the three-month period, with respect to the potential for exposure, are representative of working conditions during the period in which the quarterly bioassay frequency will be employed, and there is no reasonable expectation that the criteria set forth in 4.b.i. and 5.b.(2) above will be exceeded.

### E. [Air Monitoring of Radionuclides \(see NRC Regulatory Guide 8.25\):](#)

1. The need for air sampling to monitor possible intake of radioactive materials will be evaluated by EHS for areas in which unsealed radioactive materials are used in quantities that will exceed  $10^4$  times the annual limit of intake (ALI) (Appendix C, column 5, or Table 1 of appendix B to 10 CFR 20.1001-20.2401). EHS will, as a minimum, monitor the occupational intake of radioactive material by, and assess the committed dose equivalent to:

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- a. Adults likely to exceed 10 percent of the applicable annual limit of intake (ALI); and
  - b. Minors and declared pregnant women likely to receive, in one year, a committed dose equivalent in excess of 0.05 rem.
2. The types and frequencies of monitoring performed will depend on the quantities and chemical form of radioactive material used, and the engineering controls available to prevent intake.
  3. Excessive concentrations or exposures to airborne radioactive materials will be reported by the RSO to the user and applicable authorities, according to 10 CFR 20. Records of evaluations and air sampling results will be maintained for at least three years. Records of sample results used to determine individual intakes of radioactive materials will be kept with individual exposure records indefinitely, or until the University license is terminated.
- F. [Classification of Workplaces:](#)
1. The University uses the following guidelines, based on recommendations from the International Labor Office Guidelines for the Radiation Protection of Workers in Industry (Ionizing Radiations) Occupational Safety and Health Series 62, 1989.
  2. In view of the diversity of processes using unsealed radioactive sources and their varying levels of risk, working areas should be classified according to the relative radiotoxicity of the radionuclides, taking into account the nature of the operations and the total amount used.
  3. For this purpose, workplaces are divided into three types:
    - a. Type A or High Hazard
    - b. Type B or Moderate Hazard
    - c. Type C or Low Hazard
  4. The workplace classification is determined this way:
    - a. First, refer to [Appendix B](#) and find to which radiotoxicity group (I, II, III or IV) the radionuclide belongs. Add together the activities of all isotopes within similar hazard groups.

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[Table 3](#)

**Classification of Radioactive Workplaces**

Radiotoxicity Group (from Appendix B)	Activity Limits for Type of Workplace*		
	Type C Low Hazard	Type B Medium Hazard	Type A High Hazard
I Very High	< 10 $\mu$ Ci	10 $\mu$ Ci - 10 mCi	> 10 mCi
II High	< 100 $\mu$ Ci	100 $\mu$ Ci - 100 mCi	> 100 mCi
III Moderate	< 1 mCi	1 mCi - 1 Ci	> 1 Ci
IV Low	< 10 mCi	10 mCi - 10 Ci	> 10 Ci
Surveys Documented	Not less than Once per month	Not less than Once per week	Not less than Once per day

Multiply the activity limits by the following factors, based on the nature of the workplace operation:

<u>Operation</u>	<u>Modifying Factor</u>
Simple storage (stock solutions).	100.00
Very simple wet operations (e.g., preparation and use of aliquots of stock solutions).	10.00
Normal chemical operations (e.g., analysis, simple chemical preparations).	1.00
Complex wet operations with risk of spills (e.g., multiple operations or operations with complex glass apparatus).	0.10
Simple dry operations (e.g., manipulation of powders) and work with volatile radioactive compounds.	0.10
Exposure to non-occupational persons.	0.10
Dry and dusty operations.	0.01

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- b. Next, referring to [Table 3](#), multiply the activity limits for the radiotoxicity group by the appropriate modifying factor. The modifying factor can change frequently, as the nature of the operations change.
- c. Lastly, compare the combined activity of all isotopes within the hazard group to the modified limits. The Type of workplace classification is shown at the top of each column.

*(For example: P-32 and S-35 are routinely used in a laboratory. The radiotoxicity hazard for both of these isotopes is moderate (group III). Stock solutions are prepared, used and stored. During the weeks when solutions are prepared and used, the modifying factor is 10. Multiplying the activity limits in Table 3 by 10 shows that, for radiotoxicity group III, the workplace is Type B if the total activity of both isotopes is between 10 mCi and 10 Ci. Any weeks in which the activity used falls below 10 mCi the lab is Type C. During weeks in which solutions or waste are stored but no radioactivity is used, the modifying factor is 100. In this case, up to 100 mCi total activity can be stored in a Type C lab.)*

*(Example 2. A lab routinely purchases 5 mCi lots of I-125 sodium iodide in solution. The radiotoxicity hazard for I-125 is high (group II). Iodination's are performed, which is considered a normal chemical operation. The modifying factor during weeks when iodination's are performed is 1.0 and this lab is classified as Type B whenever 100 fuci to 100 mCi are used. If the I-125 goes into waste storage and no new I-125 is purchased, the modifying factor is 100. If less than 10 mCi is in the waste, the lab classification drops to Type C.)*

5. The following are general considerations for the design of all radioactive materials workplaces:
  - a. Workplaces of all types should be reserved exclusively for work with radioactive substances and isolated from other workplaces, as far as is practicable. Radioactive materials that are handled or used in unsealed forms should be confined to control the release of material and to prevent the spread of contamination. Gaseous, volatile, and fine particulate solid materials should be handled in closed or isolated systems such as fume hoods or glove boxes with controlled, and possibly filtered, exhaust systems.
  - b. Bench top or open work areas may be used for sealed sources, for small quantities of solid materials in a form not likely to become airborne or dispersed, and for small quantities of liquids of such low volatility as not to cause airborne contamination or toxicity problems. Trays and/or absorbent surface covers to catch and retain spilled liquids should be used on these open work surfaces and inside

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closed systems discussed below. Surfaces should be smooth and non-porous, to facilitate decontamination.

- c. Shielding consisting of lead or other high-density material in the form of bricks, panels, L-shields, storage containers, or other shapes may be used on bench tops, in fume hoods or in glove boxes to reduce radiation exposure from gamma-emitting radioactive materials. Similarly, shielding of low atomic number material, such as high-density plastic, may be used to reduce the exposure from high-energy beta-emitting materials. Shielded shipping containers are frequently used for continued storage after receipt of materials.
- d. The combination of containment, shielding, and handling devices proposed for any use of radioactive materials should be appropriate to the type and quantity of materials to be used and to the type and duration of operations to be conducted.
- e. Labeled waste containers should be used. These containers may be shielded as necessary, placed near the waste-generating areas and away from areas frequently occupied by personnel. Additionally, these containers should be effectively enclosed to prevent airborne contamination from radioactive materials deposited.
- f. A changing area should be designated at the entrances of controlled areas in order to prevent spread of contamination to outside areas. Clean clothes should be left outside the area, and protective clothing, equipment and containers for discarded, contaminated clothing should remain on the active side of the barrier.
- g. Areas with background radiation levels should be designated for personnel dosimetry storage when not in use.
- h. Washing facilities should be available which are appropriate to the level of radioactivity in the workplace. Sink faucets should be designed, where possible, for operation by foot, knee, or elbow rather than by hand.
- i. Plumbing and ductwork should be designed to avoid radioactive contamination build-up. This build-up of contamination can create external radiation exposure hazards and problems for decommissioning.

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- j. Areas of use should be well lighted to avoid spills and other accidents that could result in contamination build-up.
  - k. Before leaving a controlled area, persons should monitor their hands, feet and clothing with equipment appropriate to the type and levels of radioactive materials present.
6. Type C Workplace (Low Hazard):
- a. The design, construction and equipment of a type C workplace should be similar to those of a good-quality, modern chemical laboratory.
  - b. Normal ventilation is usually sufficient, and could be complemented with continuous movement of air into a fume hood.
7. Type B Workplace (Moderate Hazard):
- a. A type B workplace should be specially designed, constructed and equipped for work with radioisotopes.
  - b. The levels of airborne activity should be kept as low as reasonably achievable by the use of totally or partially ventilated fume hoods or glove boxes.
  - c. The workplace should have reduced air pressure relative to the surrounding areas. The ventilation exhaust should be via a fume hood. There should be a space for an absolute filter between the fume hood and the ventilation duct allowing for easy change of the filter and for monitoring the negative pressure gradient. Special attention should be given to avoiding the recirculation of air and the dispersion of contamination to other occupied areas.
  - d. The surfaces of the hood and the ventilation system should be smooth and made of non-absorbent material that can withstand the chemicals normally used in the hood.
  - e. The speed of the air flow should be regular, without eddies, and should be such that there can be no escape of air from the fume hood into the workplace under typical operating conditions, including the opening of windows and doors and the suction of other fume hoods. This should be checked regularly (see UW Fume Hood Policy). The gas, water and electrical outputs should be operated from outside the hood.

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- f. Fume hoods and glove boxes where “active” work is carried out should be properly marked with the radiation symbol and the appropriate explanatory text.
  - g. A properly labeled waste bin with a foot-operated lid should be available for the collection of low activity waste. An appropriate container should be provided for the temporary retention of liquid waste.
  - h. Facilities for washing hands should be foot or elbow operated.
  - i. A special room or area should be provided for storing radioactive substances.
8. Type A Workplace (High Hazard):
- a. A type-A workplace should be specifically designed, constructed and equipped for handling large quantities of radioactive material in accordance with the specifications and requirements set by the Radiation Safety Committee.
  - b. Processes involving risks of air contamination should be carried out in completely enclosed glove boxes or hot cells under negative pressure and provided with filters and transfer boxes.
  - c. Radioactive substances should be stored only in a special room equipped with suitable shielding and ventilation, and in accordance with the provisions as regards waste storage.

### G. [Handling, Labeling, Transporting, and Storing Radioactive Materials](#)

1. Radioactive material should be confined to designated restricted or controlled areas. The time of exposure should be minimized, maintaining the maximum feasible distance from the radioactive material. Reasonable provisions for shielding should be made, beyond the normal safety precautions taken while handling hazardous materials.
2. The following signs or labels, carrying the approved radiation symbol, are to be used as indicated.

**CAUTION- RADIOACTIVE MATERIAL** - for each accessible area in which a combined quantity of radioactive material greater than or

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equal to ten times the activity for the radionuclide from column 3, [Appendix C](#) is used or stored, or areas where doses are likely to exceed 2 millirem/hour or 100 millirem/year.

**CAUTION -RADIATION AREA** - for accessible areas in which an individual could receive an equivalent dose in excess of 5 millirem/hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

**CAUTION - HIGH RADIATION AREA** - for accessible areas in which an individual could receive an equivalent dose in excess of 100 millirem/hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

3. In most cases, a room placard is provided by EHS showing locations of storage areas, usage areas and waste storage areas for radioactive materials. The room placard also displays the radiation symbol and wording specified in the preceding paragraphs, along with emergency contact information.
4. All containers in which are used, transported or stored a combined activity greater than or equal to the amounts given in column 3, [Appendix C](#) must bear the radiation symbol and the words "CAUTION, RADIOACTIVE MATERIAL." All labels of individual containers of radioisotopes shall also include the type and quantity of nuclide, date of assay and should include the name of the responsible user. Containers used transiently while the authorized user is present are exempt from these labeling requirements.
5. Instructions for transporting radioactive material between rooms, buildings and/or field sites outside the confines of the University Campus.
  - a. Between buildings or rooms which are not immediately connected:
    - (1) Unsealed sources with activities exceeding the amounts from column 3, [Appendix C](#) must be labeled specifying the radionuclide and user. The sources should be doubly contained with enough absorbent for any liquid that might be released.
    - (2) Sealed sources must be properly labeled including the radionuclide, and activity (as of a stated date). Containers for sealed sources should identify the responsible user and return address.

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- b. Radioactive material transported outside the confines of the UW campus must be packaged according to the Department of Transportation (DOT) regulations as prescribed in 49 CFR. No radioactive material is to be taken as personal baggage in a passenger-carrying aircraft.

### H. [Methods and Frequencies for Conducting Workplace Surveys:](#)

#### 1. Workplace Survey Methods:

- a. Each workplace is required to post a schematic drawing that defines sampling and/or monitoring locations in the workplace. The sampling and monitoring sites are selected to assure adequate coverage of the workplace and such that they are sensitive to potential changes in radioactivity levels.
- b. Monitoring instruments shall be appropriate to the radiation being measured. For low energy beta or alpha radiation, or where background radiation levels hinder detection of contamination, wipe tests shall be conducted using 1" or greater diameter filter papers or cotton-tipped swabs. The filter papers or swabs are then to be counted using appropriate instrumentation.
- c. A background survey should be conducted before each survey to establish a baseline from which to compare subsequent surveys.
- d. Refer to section J, [Table 6](#) for contamination limits and decontamination methods.

#### 2. Frequency of Surveys for Routine Procedures:

- a. Surveys for contamination shall be conducted in areas where unsealed radioactive materials are used in amounts greater than or equal to 10% of the smallest annual limit on intake (either the inhalation or ingestion ALI) listed in column 5, [Appendix C](#). Detailed, documented surveys shall be performed at the frequencies specified in [Table 3](#). Survey forms may be developed by the user, or are available from EHS.
  - (1) Type A - not less than once per working day
  - (2) Type B - not less than once per week

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- (3) Type C - not less than once a month
  - b. Workplaces where unsealed radioactive materials are used in amounts specified in (a) above will be inspected quarterly by EHS personnel. These inspections will include a radiation safety audit and a preliminary survey with a hand-held instrument. In addition to the above inspections, EHS will do wipe-test surveys of these radioisotope workplaces every six months to check for removable contamination.
3. Non-Routine Procedures:
- a. Personnel should be in the habit of surveying immediately following procedures where radioactive materials are used. At the very least, however, surveys shall be conducted immediately after the following cases:
    - (1) If the procedures are one-time only
    - (2) If the procedures are performed on a less frequent basis than the survey frequency specified in [Table 3](#)
    - (3) If there is a significant change in the quantities of radioactive material handled, procedures or protective equipment used
    - (4) If previous surveys, personnel monitoring or bioassays indicate a possible contamination problem which should be checked more closely
4. Instrumentation:
- a. Except for the use of isotopes (such as tritium) which emit low energy radiation or areas where only X-or gamma emitting isotopes are used where radiation levels are less than 0.2 mR/hour, each workplace shall maintain appropriate operational survey instruments according to Tables 4 and 5 below.

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**Table 4. Operational Instruments for Workplaces**

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<u>Workplace Classification</u>	<u>Minimum Number of Operational Instruments Required</u>
Type C (Low Hazard)	1 with a backup instrument identified
Type B (Moderate Hazard)	2 with a backup instrument identified

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Type A (High Hazard)

2 with a backup instrument identified

**Table 5. Typical Survey Instruments<sup>1</sup>**

<b>Portable Instruments Used for Contamination and Ambient Radiation Surveys</b>			
<b>Detectors</b>	<b>Radiation</b>	<b>Energy Range</b>	<b>Efficiency</b>
Exposure Rate Meters	Gamma, X-ray	μR-R	N/A
Count Rate Meters			
GM	Alpha	All energies (dependent on window thickness)	Moderate
	Beta	All energies (dependent on window thickness)	Moderate
	Gamma	All energies	< 1%
Nal Scintillator	Gamma	All energies (dependent on crystal thickness)	Moderate
Plastic Scintillator	Beta	C-14 or higher (dependent on window thickness)	Moderate
<b>Stationary Instruments Used to Measure Wipe, Bioassay, and Effluent Samples</b>			
<b>Detectors</b>	<b>Radiation</b>	<b>Energy Range</b>	<b>Efficiency</b>
LSC*	Alpha	All energies	High
	Beta	All energies	High
	Gamma		Moderate
Gamma Counter (Nal)*	Gamma	All energies	High
Gas Proportional	Alpha	All energies	High
	Beta	All energies	Moderate
	Gamma	All energies	< 1%

<sup>1</sup> Table from The Health Physics & Radiological Health Handbook, Revised Edition, 1992 (except for \* items).

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5. Hand-held Survey Procedures:
  - a. Before each survey, turn the instrument on, check to see if it is operating, has fresh batteries and has been calibrated within the last year. Using the check source issued, compare the instrument's response with the reading written on the calibration label. If the response varies more than 20% from the written value, or if there are any other problems, call EHS for assistance.
  - b. Make note of the background radiation level.
  - c. Follow the workplace survey diagram. With the audio on, or while watching the meter face, hold the instrument within 1 inch from the surfaces (but not touching) and sweep slowly back and forth. Pay particular attention to areas of potential contamination and items (such as handles) that could have been touch with contaminated hands. If no spots are found that exceed two times the background value, record the average counts for each areas surveyed. If contamination exceeds two times background, write down the average value for the "hot spot".
  - d. In recording survey values use the proper units (cpm, dpm, mR/hour, mrem/hour). To determine accurate disintegrations-per-minute (dpm) or exposure levels (mrem/hour) you must first subtract the background, then divide the net counts by the instrument's efficiency for the isotope detected. The efficiency for beta radiation (at 1 inch from the source) increases with beta energy and is written on the calibration label for three specific sources: C-14 (0.157 MeV), Tc-99 (0.292 MeV) and Sr/Y-90 (2.281 MeV). Efficiencies for other beta emitters not listed can be approximated from these values, based on their maximum beta energies.

### I. [Contamination Control Practices:](#)

1. Personal Contamination:
  - a. Contamination external to the body should be detected and removed as rapidly as practicable to prevent its spread to other surface areas or potential uptake by the body. The following procedures are encouraged to reduce the risks of external contamination:

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- (1) Incoming shipments of radioisotopes are checked by EHS for breakage and external contamination as required by DOT regulations.
- (2) Appropriate protective apparel (lab coats, aprons, safety glasses, gloves, etc.) should be available to radiation workers, and shall be worn when unsealed radioactive materials are used.
- (3) Secondary containers lined with absorbent material should be used when radioactive materials are being handled.
- (4) A radiation worker's hands and clothing shall be thoroughly surveyed after handling potentially contaminated materials.
- (5) Be prepared for emergencies: Become familiar with emergency procedures. Know the location of safety showers, eyewash stations and other emergency equipment.
- (6) Plainly label all hazardous materials, including radioactive materials, according to section G above.
- (7) Follow good housekeeping practices to avoid accidents.

### 2. Internal Contamination:

- a. The following precautions are to be taken when working with unsealed radioactive materials in order to prevent the intake of these materials into the body:
  - (1) Foods and beverages are not to be consumed or stored in areas where unsealed radioactive materials are stored or used. If any food or beverage containers are found in radioactive workplaces by EHS, they may be confiscated until they are determined not to be contaminated. Any foodstuffs will be discarded.
  - (2) Smoking is not permitted in workplaces where radioactive materials are used.
  - (3) Applying cosmetics while in radiation workplaces is prohibited.

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- (4) All pipetting of radioactive materials shall be done by mechanical methods, i.e. not by mouth.
- (5) When fume hoods are required, they must be approved by EHS. Bioassay procedures other than urine samples may be required when larger than normal quantities of unsealed radioactive material are handled depending on the isotope and the amount of activity. Such situations: will be evaluated by the RSO and the Radiation Safety Committee on an individual basis.

### 3. Protective Clothing:

- a. Appropriate protective clothing must be provided and worn for the purpose of preventing contamination to the skin or clothing of the radiation worker. In general, when using activity greater than ten times the amounts from column 3, [Appendix C](#), a minimum of rubber gloves, laboratory coats of tightly woven fabrics, and eye protection are required. Shoe covers and/or coveralls may be required, depending on the activity levels and potential for floor contamination.
- b. Rubber gloves and shoe covers should be considered as potentially contaminated unless demonstrated otherwise. Gloves and shoe covers should be removed in a manner that does not contaminate uncovered portions of the skin.
- c. Users should not touch uncovered portions of the skin, reach into pockets or handle any items not required in the experiment while wearing rubber gloves.
- d. Lead impregnated aprons; gloves or other garments may be required for protection from low energy gamma or x-rays.
- e. When the potential for serious contamination exists, more elaborate protective clothing may be required on a case-by-case basis with review and approval by the RSO.
- f. Protective clothing worn by radiation workers must be kept separate from protective clothing of other workers. The clothing must be distinctively and permanently marked.

### J. [Decontamination:](#)

1. It is the responsibility of the Principal User to see that decontamination is carried out properly by making spills kits readily available and instructing personnel in decontamination procedures.

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EHS may provide assistance or supervision in cases of gross or personal contamination that the user cannot handle him/herself. In general, start from areas of low contamination and work towards higher contaminated areas. Volumes of solids and liquids used in decontamination should be minimized because they must be saved as radioactive waste.

2. For skin contamination, wash the contaminated area for two (2) minutes using a mild, pure soap and tepid (luke-warm) water. Pay particular attention to areas between fingers or around fingernails. If the contamination is widespread, shower with mild soap and warm water, then re-survey to localize any remaining contamination. Once the contamination is localized, consider masking off the area with tape and cleaning with swabs. Rinse the contaminated area thoroughly, dry and count.

If soap and water alone do not remove the contamination, repeat the two (2) minute wash using a soft brush to help remove the contamination. Use light pressure and change wash water frequently. Rinse, dry and count. Repeat up to three times unless the skin starts to turn red. If the contamination cannot be brought to within acceptable limits, contact the RSO or hospital as soon as possible.

3. Contaminated clothing should be bagged and turned over to EHS for storage to allow for radioactive decay, decontamination or disposal.
4. Glassware and other contaminated equipment should be cleaned using laboratory detergents, acids, or cleaning solutions as appropriate. All equipment contaminated with long-lived radionuclides, which cannot be cleaned to acceptable levels, must be labeled and should not be used in uncontrolled areas. Equipment contaminated with short-lived radionuclides can be stored in a secure location to allow for radioactive decay.
5. Workplace work surfaces and floors which cannot be decontaminated to acceptable levels must be treated to fix the radioactivity in place and shielded to bring exposure limits to acceptable levels. These should be identified as contaminated areas, isolated to allow for radioactive decay or decommissioned.
5. Levels of contamination on skin, clothing, radioactive work surfaces, equipment and facilities should be kept as low as reasonably achievable. Maximum acceptable limits of contamination to personnel and non-restricted areas are set forth in

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Tables 6 and 7.

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**Table 6. Removable Contamination Limits for Personnel or Work Surfaces**

(From NRC Regulatory Guide 23 Rev. 1, 1981)

Type of Surface	Alpha Emitters		Beta or Photon Emitters		Low-Risk Beta or Photon Emitters*	
	uci/cm <sup>2</sup>	dpm/100cm <sup>2</sup>	uci/cm <sup>2</sup>	dpm/100cm <sup>2</sup>	uci/cm <sup>2</sup>	Dpm/100cm <sup>2</sup>
Controlled areas	10 <sup>-6</sup>	220	10 <sup>-5</sup>	2,200	10 <sup>-4</sup>	22,000
Personal clothing worn outside controlled areas	10 <sup>-7</sup>	22	10 <sup>-6</sup>	220	10 <sup>-5</sup>	2,200
Protective clothing worn only in controlled areas	10 <sup>-6</sup>	220	10 <sup>-5</sup>	2,200	10 <sup>-4</sup>	22,000
Skin	10 <sup>-6</sup>	220	10 <sup>-6</sup>	220	10 <sup>-5</sup>	2,200

\*Low risk beta or photon emitters are: H-3, C-14, P-33, S-35, Cr-51 and others whose beta energies are less than 0.2 MeV maximum, whose photon emission is less than 0.1 R/h at 1 meter per curie, and whose permissible concentration in air (see 10 CFR 20, Appendix B, Table 1) is greater than 10<sup>-6</sup> uCi/ml.

**Table 7. Acceptable surface Contamination Levels in Uncontrolled Areas**

Nuclide <sup>1</sup>	Average <sup>2,3</sup>	Maximum <sup>2,4</sup>	Removable <sup>2,5</sup>
U-nat, <sup>235</sup> U, <sup>238</sup> U, and associated decay products	5,000 dpm α/100cm <sup>2</sup>	15,000 dpm α/100cm <sup>2</sup>	1,000 dpm α/100cm <sup>2</sup>
Transuranics, <sup>226</sup> Ra, <sup>228</sup> Ra, <sup>230</sup> Th, <sup>228</sup> Th, <sup>231</sup> Pa, <sup>227</sup> Ac, <sup>125</sup> I, <sup>129</sup> I	100 dpm /100cm <sup>2</sup>	300 dpm /100cm <sup>2</sup>	20 dpm /100cm <sup>2</sup>
Th-nat, <sup>232</sup> Th, <sup>90</sup> Sr, <sup>223</sup> Ra, <sup>224</sup> Ra, <sup>232</sup> U, <sup>126</sup> I, <sup>131</sup> I, <sup>133</sup> I	1,000 dpm /100cm <sup>2</sup>	3,000 dpm /100cm <sup>2</sup>	200 dpm /100cm <sup>20</sup>
Beta-gamma emitters (nuclides wit decay modes other than alpha emission or spontaneous fission) except <sup>90</sup> Sr and others noted above.	5,000 dpm /100cm <sup>2</sup>	15,000 dpm /100cm <sup>2</sup>	1,000 dpm /100cm <sup>2</sup>

<sup>1</sup> When contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha- and beta-gamma-emitting nuclides should apply independently.

<sup>2</sup> As used in this table, dpm (disintegration per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

<sup>3</sup> Measurements of average contaminant should not be averaged over more than 1 square meter. For objects of less surface area, the average should be derived for each such object.

<sup>4</sup> The maximum contamination level applies to an area of not more than 100 cm<sup>2</sup>.

<sup>5</sup> The amount of removable radioactive material per 100 cm<sup>2</sup> of surface area should be determined by wiping that area, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

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6. Equipment contaminated at higher levels because of the nature of the equipment design, levels of activity handled or other special factors must be located in restricted areas. These areas shall be designated as radiation areas if the exposure rate exceeds 5 mR/hour at 30 centimeters.
  7. Contamination in uncontrolled areas should be immediately decontaminated to background levels. When it is not possible to get to background levels, the contamination should not exceed the levels in [Table 7](#).
- K. [Emergency Procedures for Radiation Accidents and the Loss of Radioactive Material:](#)
1. It is the responsibility of the Principal User to instruct their personnel in emergency procedures and the location of emergency equipment.
  2. Preparedness for emergencies is essential. Each campus department and building is required to prepare its own emergency response plan that fits within the university-wide plan. See the University Environmental Health and Safety Manual for details.
  3. Model procedures for Radiological emergency response can be found in [Appendix E](#).
- L. [Neutron, Alpha and Spontaneous Fission Sources](#)
1. Users of neutron or alpha emitters and radionuclides that decay by spontaneous fission must have appropriate detection equipment approved by the RSO. When such sources have a potential of becoming airborne, air monitoring methods must be approved by the Radiation Safety Committee. Neutron dosimeters must be worn by all personnel who may receive significant neutron exposure. Workplaces and storage areas may be required to be monitored as determined by the Radiation Safety Committee.
  2. Users must also be specifically trained concerning the biological hazards and handling techniques of these sources on a case-by-case basis.
  3. Signs and barriers shall be posted or constructed to alert workers or the public of the possible radiation hazard involved. Barriers should be constructed in a manner to cause minimum interference with the work being done. When not occupied by authorized personnel, the area must be locked or otherwise made

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inaccessible.

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### M. [Leak Testing of Sealed Sources:](#)

Sealed sources will be leak tested by EHS according to conditions specified in the byproduct materials license issued to the University by the U.S. Nuclear Regulatory Commission.

### IV. [Operating Procedures:](#)

#### A. [Program Applications and Approvals:](#)

1. An application for use of radioactive materials or radiation devices is required for all new users, new programs, and new facilities. The current form and other directions, etc. required by the Radiation Safety Committee are available through EHS. The application is reviewed by the RSO, who submits it with comments and/or recommendations at the next scheduled meeting of the RSC for action. The applicant may be asked to attend the meeting. (All Radiation Safety Committee meetings are open to those wishing to attend.) The RSO may issue a temporary approval pending a Radiation Safety Committee meeting.
2. Applications for principal users are approved for specific isotopes or radiation devices, types of experiments, and periods of time. Major revisions in a user program require an amended or new application.
3. If an application is allowed to expire the principal user will need to re-apply before radiation sources can be used in the workplace. If the principal user does not wish to re-apply, then all radioactive accounts must be closed out with EHS.
4. Applications must contain all of the information needed by the committee to evaluate both the legal and safety aspects of the application; in particular, the following items should be included:
  - a. Pertinent training and experience of a new user applicant. Minimum requirements for principal and independent users are listed in part C of this section.
  - b. Names and qualification of all persons to be involved in the proposed program.
  - c. Types and quantities of radioactive materials to be used (or description of a radiation generating machine and its output, if appropriate).
  - d. Purpose of the proposed program with regard to teaching,

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research, etc.

- e. Specific locations and facilities to be utilized (e.g. buildings, rooms, storage facilities, hoods available, etc.).
- f. Instruments and techniques to be used to evaluate exposures or contamination.
- g. Types and quantities of wastes expected, and proposed methods of waste packaging and disposal.
- h. Administrative controls and provisions for record keeping, material control and accounting, and management review to assure safe operation.

### B. [Acquisition and Transfer of Radiation Sources:](#)

1. All shipments of radiation sources must be ordered or processed through Environmental Health and Safety. This requirement also applies to no-charge and generally licensed acquisitions. All orders will be checked by the RSO to verify that they are in accordance with authorizations of the Radiation Safety Committee and the conditions of the University's NRC by-product license. EHS takes possession of all radioactive shipments, surveys and/or leak tests them as required, checks the delivery against the original order, and delivers them to the authorized user.
2. All transfers of radiation sources from one principal user to another must be processed through EHS to ensure that Federal, State and University regulations are satisfied. The RSO may give special approval for specific users to transfer radioactive materials within a designated group and to file the paperwork with EHS afterward. Radioactive shipments off campus must also be processed through EHS.

### C. [Security Over Licensed Materials:](#)

1. A RESTRICTED AREA is one in which security is used to prevent undue risk from exposure from radiation or radioactive materials. All entrances to restricted areas shall remain closed and locked when not under constant surveillance by authorized personnel.
2. A CONTROLLED AREA is a limited access area in which:
  - a. Combined quantities of licensed materials are used or stored in amounts greater than or equal to ten times the activities

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for the radionuclides from column 3, [Appendix C](#).

- b. Doses to visitors could exceed 100 mrem in one year or 2 millirem in one hour. Access is controlled through signage, door locks, locked storage and/or the surveillance of authorized personnel. Licensed radioactive materials stored or used in controlled or unrestricted areas shall remain either under the surveillance of authorized personnel or else secured from unauthorized removal or access.

### D. [Physical Inventories of Radioactive Materials:](#)

1. Each Principal User shall keep records of physical inventories of all radioactive materials under his/her control. This inventory should include information on isotope, activity and date. For unsealed sources the inventory records should also include sufficient additional information to facilitate locating the materials. At least every six months the user should visually verify the locations of all materials inventoried. The Principal User is responsible for ensuring that the records are kept current and accurate. EHS will inspect these records periodically.

### E. [Training and Experience of Personnel in Controlled or Restricted Areas:](#)

1. NRC and OSHA require persons working with radioactive materials or radiation sources to have training and experience which suits the classifications of the user (principal, independent, supervised) and work place, based on the levels and types of radiation sources being used. The worker's level of proficiency should be demonstrated through documentation or testing.
2. Supervised Users:
  - a. All authorized persons frequenting restricted or control areas must be instructed in, or demonstrate through documentation or testing a knowledge of the following subjects:
    - (1) Applicable regulations, license conditions and University rules and regulations, and locations where copies of pertinent regulations, licenses and other material required by regulations are posted or made available.
    - (2) Areas where radiation sources are used or stored.

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- (3) Potential hazards associated with radiation sources. This training should include: the safe handling of radiation sources, the characteristics of ionizing radiation, units of radiation dose and quantities, radiation detection instrumentation, and biological hazards of exposure to radiation appropriate to the type and forms of radiation sources to be used.
  - (4) Appropriate radiation safety practices.
  - (5) Individual's obligation to report unsafe conditions to the RSO and/or applicable authorities.
  - (6) Appropriate response to emergencies or unsafe conditions
  - (7) Worker's right to be informed of occupational radiation exposure and bioassay results.
- b. This training: will be provided by the RSO, the Principal User, and/or a documented source approved by the RSO. In addition, the person should receive documented training regarding the individual hazards in the workplace. For Type C workplaces the radiation safety training can be obtained within six months of employment, as long as the person receives initial instructions from the principal user. If substitute training is from another institution, individuals should still receive instruction on University of Wyoming policies and procedures. All users should read and have available a copy of this Radiation Safety Manual.

### 3. Independent User:

The designation of Independent User is at the discretion of the principal user. An independent user must, in addition to the same documented training as a supervised user, have at least 40 hours of documented training or experience using similar radiation sources and procedures. Independent users should also be familiar with administrative controls and provisions related to procurement of radiation sources, record keeping, material control and management review. For Type C workplaces, this training can be gained while the person works as a supervised user under the applicant or some other authorized principal user. The principle user is responsible for providing documentation to the RSO on the staff member's completion of his/her instruction and certification of the worker's ability to use materials with limited or no supervision.

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### 4. Principal User:

A principal user must, at a minimum, have the same training and/or experience as that required for an independent user (Radiation Safety plus 40 hours experience). He/she should also demonstrate proficiency in his/her field and knowledge of sound laboratory practices in order to assume full responsibility for the safety and actions of subordinates. Previous laboratory management experience is desired. If the RSC does not feel that the training or experience of the applicant is sufficient, they may require that the applicant work under an authorized principal user for a period of time to gain the experience needed.

### 5. Classification of Workplace:

a. Section II-E of the Radiation Safety Manual gives guidelines for the classification of workplaces based on the radiotoxicity and quantities of the radionuclide proposed. For each workplace classification, there are suggested levels of educational background, training and experience.

#### b. Type C Workplace:

In general, a Type C (low hazard) workplace is similar to a traditional chemistry lab. Refer to the training requirements under the University's Chemical Hygiene Program. A Bachelors degree or equivalent experience in a Science related field and knowledge of the basic principles of Chemistry and Physics is common for all classifications of workers.

#### c. Type B Workplace:

To work in a Type B (moderate hazard) workplace, a supervised user should have a bachelor's degree or equivalent experience in science and have taken courses in Chemistry, Physics, Microbiology, Biochemistry, Biology, Zoology or other applied sciences. Supervised users must have radiation safety training prior to being allowed to work with radionuclides in Type B quantities. Independent users should also have the required 40 hours of documented training or experience with radionuclides in Type B quantities. Principal users should have a Ph.D. or equivalent, with formal courses in Radiation Physics, Radiochemistry, or Radioisotope Techniques. Laboratory management

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experience is preferred.

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d. Type A Workplace:

In a Type A (high hazard) workplace all workers must have previous experience and training sufficient to work with radioactive materials of the type and quantities for which the application is submitted. A Masters level of education, training or experience is preferred for all users. Independent users should have 40 hours of training or supervised experience, using radionuclides in Type A quantities, with formal courses in Radiochemistry, Radiation Physics or Radioisotope Techniques preferred. The Principal user should be at the Ph.D. level, with training in Radiochemistry, Radiation Biology, Radioisotope Techniques or Radiation Physics, and documented experience with high radiotoxic materials in his field of study.

6. Students in Radioisotope Classes:

No previous training or experience is necessary in laboratory classes designed and used to teach radiation safety, radioactive principles, or radioactive techniques. Students under 18 are not permitted to work with radioisotopes in amounts exceeding that generally licensed by the NRC without specific approval of the Radiation Safety Committee.

7. Users of Sealed Radioactive Sources:

Users may be permitted to work with sealed radioactive sources incorporated into measurement instruments without direct supervision of an independent or principal user provided:

- a. The student has at least four hours of training on safe handling of radioactive materials, characteristics of ionizing radiation, units of radiation equivalent dose and quantities, radiation detection instrumentation, and biological hazard of exposure to radiation appropriate to the type and forms of by-product material used.
- b. The student has had “hands-on training” in the proper use of the instrument for at least one-half day of field or laboratory use.
- c. Written instructions on operating and emergency procedures are immediately available.
- d. The student does not work without another person in the vicinity available for assistance.

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### F. [Disposal of Radioactive Wastes:](#)

All waste radioactive material must be collected, properly packaged and labeled by the user. See the guidelines on preparing for waste disposal in [Appendix D](#) and [Appendix F](#). Waste is routinely picked up and stored by EHS until final disposal in accordance with the University's NRC license.

### G. [Closing Radioactive Accounts:](#)

Principal users who leave the University or otherwise discontinue the use of radioactivity are required to promptly close out radioactive accounts with EHS. All radioactivity left in the accounts must be processed through EHS. A workplace close-out survey for radioactive contamination will be performed by EHS.

### H. [Special Requirements for Administering Radionuclides to Animals:](#)

Radioactive sources shall not be used on animals without the approval of the RSO and the Radiation Safety Committee. Items that must be considered in applying for the use of radionuclides in animals are:

1. Animals that are administered radioactive materials are to be regarded as a source of radiation and contamination. They should be grouped separate from other animals and their rooms or cages should be regarded as controlled areas.
2. Animals or cages are to be marked with labels indicating the radionuclide, the amount of activity administered and the time of administration of the radionuclide.
3. Cages and/or rooms must be secure to prevent unwarranted spread of contamination by animals or animal excreta. No uncontrolled exchange of animals, instruments, cages, etc. between radioactive and non-radioactive workplaces is permitted.
4. Loitering near radioactive animals should be avoided.
5. The quantity of radioactive material on hand should be limited as far as reasonable to the amount required for the treatment.
6. Provision for collection of excreta and decontamination of cages is required. Excreta, bedding, body constituents from biopsies and autopsies and animal cadavers shall be treated as radioactive waste. See Appendix D for proper disposal procedures.
7. Possible hazards of spread of contamination through the

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## Radiation Safety Manual

decomposition process should be prevented by deep freezing, disinfectants, sealed plastic containers, and other approved methods.

8. Besides the usual initial classroom training in radiation safety, animal attendants shall have appropriate on-the-job training from authorized Principal Users or Independent Users. This training should include observation and practice in surveys, contamination control and waste disposal methods.
9. Animal handlers shall wear appropriate protective apparel, such as gloves, lab coat, eye protection, etc. Precautions should be taken to prevent contaminating wounds in the course of handling animals. Contamination from radioactive aerosols or splashing produced by animal movements, coughing, etc. should also be considered.
10. The presence of vermin as potential vectors of contamination should also be considered.
11. NIH, USDA, FDA, EPA and other regulations associated with animal treatment and welfare shall be followed, and the University Animal Care Committee must be consulted.

### V. Record Requirements:

#### A. Authorizations and Qualifications:

All actions of the Radiation Safety Committee pertaining to applications, qualifications and authorizations of users of radiation sources are to be recorded in the minutes of committee meetings and maintained as permanent records. In addition, the actual applications and statements of qualifications are to be maintained, together with descriptions of authorized programs in a central file under the supervision of the RSO.

#### B. Inventories and Disposals:

Each principal user must ensure that complete records are maintained of all radioactive materials used under his/her jurisdiction. The inventory records must identify the materials accurately and account for all receipts, disposals and actual amounts on hand at any time. A central inventory of all materials acquired under the University's license is maintained by EHS.

#### C. Surveys and Assays:

A permanent record is to be maintained by each principal user of all surveys and assays conducted of facilities, materials and personnel under

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his jurisdiction. Copies of these items are also to be provided to EHS for inclusion in the central files.

D. [Exposures:](#)

Exposure data obtained from previous occupational exposures, external personal monitoring devices and from bioassay procedures are to be maintained for all radiation users and any other persons exposed to radiation sources (except for prescribed medical exposures). These records are to be kept in a central file and reviewed by the Radiation Safety Officer or staff. Users will be notified if they receive an exposure of concern. Any individual may obtain a summary of his own exposure record upon written request of EHS. Users are provided an annual summary of their exposure records.

E. [Training:](#)

Documentation of radioactive worker training provided by the RSO, Principal Users or other sources within or outside the University, including performance-based, refresher and specialized training, shall be provided to and retained by EHS.

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[Appendix A - Documents Available at EHS and RSC Member List](#)

## UNIVERSITY OF WYOMING

July 1, 2004

The following documents are available for inspection in the Environmental Health & Safety Office, Merica Hall, Room 312, Campus.

1. A current copy of NRC Code of Federal Regulations (10CFR) including parts 19 and 20.
2. University of Wyoming Byproduct Materials License and amendments thereto.
3. Operating procedures applicable to licensed activities.
4. Any NRC notice of violation(s), proposed civil penalties, and/or orders will be posted on the bulletin board outside of the Environmental Health & Safety office, Merica Hall, Room 303 within two (2) days after issuance by the USAEC and will remain posted for a minimum of five (5) working days or until corrective action has been completed, whichever is later.
5. USNRC form NRC-3, "Notice to Employees."
6. University of Wyoming Radiation Safety Manual.

Members of the Radiation Safety Committee are as follows:

Gary Moss (Chair)	Animal Science
Jim Herrold	Radiation Safety Officer
David Stephenson	Molecular Biology
Bill Wilson	USDA/ARS
Roger Wilmot	Research Office
Joan Smith-Sonneborn	Arts & Science College
Edward Oleske	Finance Office
Derek Smith	Health Sciences College

Questions pertaining to the University Radiological Control Program should be directed to Jim Herrold, Radiation Safety Officer, or to a member of the Radiation Safety Committee. A current copy of this notice must be posted in all approved laboratories using radioactive materials.

### **Environmental Health & Safety**

Department 3413  
Room 303, Merica Hall  
1000 E. University Ave.  
Laramie, Wyoming 82071

### **Phone Numbers**

Merica Office: (307) 766-3277  
Merica Fax: (307) 766-5678  
RMMC Office (307) 766-3696  
RMMC Fax (307) 766-3699

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### Appendix B - Radiotoxicity Hazard From Absorption Into the Body

(adapted from NBS handbook 92)

#### Group I. Very High Toxicity:

\*Pb<sup>210</sup>, Po<sup>210</sup>, \*Ra<sup>226</sup>, \*Ra<sup>228</sup>, Ac<sup>227</sup>, Th<sup>227</sup>, Th<sup>228</sup>, Th<sup>230</sup>, Pa<sup>231</sup>, U<sup>233</sup>, Np<sup>237</sup>, Pu<sup>238</sup>, Pu<sup>239</sup>, Pu<sup>240</sup>, Pu<sup>241</sup>, Pu<sup>242</sup>, \*Am<sup>241</sup>, Am<sup>243</sup>, Cm<sup>242</sup>, Cm<sup>244</sup>, Cf<sup>249</sup>

#### Group II. High Toxicity:

\*Na<sup>22</sup>, Cl<sup>36</sup>, Ca<sup>45</sup>, \*Sc<sup>46</sup>, Co<sup>56</sup>, \*Co<sup>60</sup>, Sr<sup>90</sup>, Zr<sup>95</sup>, \*Ru<sup>106</sup>, I<sup>125</sup>, I<sup>129</sup>, \*I<sup>131</sup>, Sb<sup>125</sup>, Cs<sup>137</sup>, \*Ce<sup>144</sup>, \*Eu<sup>154</sup>, Hf<sup>181</sup>, \*Ta<sup>182</sup>, Ir<sup>192</sup>, Bi<sup>207</sup>, Bi<sup>210</sup>, At<sup>211</sup>, Ra<sup>224</sup>, Ac<sup>228</sup>,

#### Group III. Moderate Toxicity:

\*Be<sup>7</sup>, C<sup>14</sup>, Na<sup>24</sup>, Si<sup>31</sup>, P<sup>32</sup>, P<sup>33</sup>, S<sup>35</sup>, Cl<sup>36</sup>, \*K<sup>42</sup>, Sc<sup>47</sup>, Sc<sup>48</sup>, \*V<sup>48</sup>, Cr<sup>51</sup>, \*Mn<sup>54</sup>, \*Mn<sup>56</sup>, Fe<sup>55</sup>, \*Fe<sup>59</sup>, \*Cu<sup>64</sup>, \*Zn<sup>65</sup>, Zn<sup>69m</sup>, \*Ga<sup>72</sup>, Se<sup>75</sup>, \*As<sup>76</sup>, \*Rb<sup>86</sup>, Sr<sup>89</sup>, Sr<sup>91</sup>, Y<sup>90</sup>, Y<sup>91</sup>, \*Nb<sup>95</sup>, \*Mo<sup>99</sup>, \*Ru<sup>103</sup>, \*Rh<sup>105</sup>, Pd<sup>103</sup>, Ag<sup>105</sup>, Ag<sup>111</sup>, \*Cd<sup>109</sup>, \*Sn<sup>113</sup>, Te<sup>125m</sup>, \*Te<sup>127</sup>, \*Te<sup>129m</sup>, \*Ba<sup>140</sup>, \*La<sup>140</sup>, \*La<sup>140</sup>, Pr<sup>143</sup>, Pm<sup>147</sup>, Sm<sup>151</sup>, Gd<sup>153</sup>, \*Ho<sup>166</sup>, \*Tm<sup>170</sup>, \*Lu<sup>177</sup>, \*Re<sup>183</sup>, W<sup>187</sup>, \*Ir<sup>190</sup>, \*Pt<sup>191</sup>, \*Pt<sup>193</sup>, \*Au<sup>196</sup>, \*Au<sup>198</sup>, \*Au<sup>199</sup>, \*Ti<sup>200</sup>, \*Ti<sup>201</sup>, Ti<sup>202</sup>, Ti<sup>204</sup>, \*Pb<sup>203</sup>, Rn<sup>220</sup>, \*Rn<sup>222</sup>, U<sup>235</sup>

#### Group IV. Low Toxicity:

H<sup>3</sup>, O<sup>15</sup>, F<sup>18</sup>, Co<sup>58m</sup>, Ni<sup>59</sup>, Zn<sup>69</sup>, Ge<sup>71</sup>, Kr<sup>85</sup>, Rb<sup>87</sup>, Nb<sup>97</sup>, Tc<sup>99m</sup>, Rh<sup>103m</sup>, Cs<sup>125</sup>, Xe<sup>131m</sup>, Os<sup>191m</sup>, Th<sup>232</sup>, U<sup>238</sup>, Natural Thorium, Natural Uranium, Noble Gases.

\*Emits gamma radiation in significant amounts.

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## [Appendix C – Isotope-specific information used for radiation protection\\*](#)

Column 1 Radionuclide (type of decay)	Column 2 Half life	Column 3 Quantities Requiring Labeling (μCi)	Column 4 External Dose	Column 5			
				Lung clearance class [D (days), W (weeks), Y (years)] and assigned chemical compounds	Occupational Values		
					Oral Ingestion ALI μCi	Inhalation	
					ALI μCi	DAC μCi/ml	
C-14 (CO <sub>2</sub> ) (β <sup>-</sup> )	5730 y	1,000	< 10	Monoxide dioxide compounds	-- -- 2E+3	2E+6 2E+5 2E+3	7E-4 9E-5 1E-6
Ca-45 (β <sup>-</sup> )	163 d	100	< 10	W, all compounds	2E+1	8E+2	4E-7
Cd-109 (ε,γ,e <sup>-</sup> )	464 d	1		D, all other compounds	3E+2	4E+1	1E-8
				kidneys	(4E+2)	(5E+1)	--
				W, sulfides, halides, and nitrates	--	1E+2	5E-8
				kidneys	--	(1E+1)	--
				Y, oxides and hydroxides	--	1E+1	5E-8
Cr-51 (ε,γ)	27.704 d	1,000	-----	D, all other compounds	4E+4	5E+4	2E-5
				W, halides and nitrates	--	2E+4	1E-5
				Y, oxides and hydroxides	--	2E+4	8E-6
Cu-64 (β <sup>-</sup> ,β <sup>+</sup> ,ε)	12.701 h	1,000		D, all other compounds	1E+4	3E+4	1E-5
				W, halides and nitrates	--	2E+4	1E-5
				Y, oxides and hydroxides	--	2E+4	9E-6
H-3 (β <sup>-</sup> )	12.35 y	1,000	< 0.2	Water, DAC includes skin absorption	8E+4	8E+4	2E-5
				Gas (HY or T <sub>2</sub> ) submersion	8E+4	8E+4	2E-5
I-125 (ε,γ,e <sup>-</sup> )	60.14 d	1	1,400 @ 1 cm	D, all compounds	4E+1	6E+1	3E-8
				thyroid	(1E+2)	(2E+2)	--
Na-22 (β <sup>+</sup> ,γ)	2.602 y	10	11,800 @ 1cm	D, all compounds	4E+2	6E+2	3E-7
P-32 (β <sup>-</sup> )	14.29 d	10	< 10	D, all compounds except phosphates given for W	6E+2	9E+2	4E-7
				W, phosphates of Zn <sup>2+</sup> , S <sup>3+</sup> , Mg <sup>2+</sup> , Fe <sup>3+</sup> , Bi <sup>3+</sup> , and lanthanides	--	4E+2	2E-7
P-33 (β <sup>-</sup> )	25.3 d	100	< 10	D, see P-32	6E+3	8E+3	4E-6
				W, see P-32	--	3E+3	1E-6
S-35 (β <sup>-</sup> )	87.44 d	100	< 10	Vapor	--	1E+4	6E-6
				D, sulfides and sulfates except those given for W	1E+4	2E+4	7E-6
				LLI wall (8E+3)	--	--	--
				W, elemental sulfur, sulfides of Sr, Ba, Ge, Sn, Pb, As, Sb, Bi, Cu, Ag, Au, Zn, Cd, Hg, W, and Mo. Sulfates of Ca, Sr, Ba, Ra, As, Sb, and Bi	6E+3	2E+3	9E-7
Se-75 (ε,γ)	119.8 d	100		D, all other compounds	5E+2	7E+2	3E-7
				W, oxides, hydroxides, carbides, and elemental Se	--	6E+2	3E-7

\* For radioisotope not listed, refer to Appendices B and C or 10CFR 20.1001-20.2401

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### [Appendix D - Procedures for the Safe and Correct Disposal of Radioactive Waste](#)

Before the call to EHS for a Radioactive Waste pickup is made, it is important to have the materials and paperwork in order. EHS may refuse to pick up waste if it is not properly packaged, labeled and documented. It is the responsibility of the principal investigator to make sure the lab personnel are trained in these procedures.

#### 1. **The waste should be in proper, well-sealed containers:**

**Liquid waste:** 20-liter carboys are available at EHS, for which there is a charge. These jugs will become the property of the authorized user's lab and will be returned when emptied. Some of the isotopes with shorter half-lives (primarily P-32 and I-125) will have to be decayed out before disposal, so additional containers may need to be purchased.

If labs do not dispose of large amounts of liquids, or if there are other concerns about having to use the 20-liter sized carboys, EHS will try to work something out. Waste will not, however, be accepted in containers that are not either distributed or authorized by EHS.

**Solid waste:** All solid waste should be kept out of the liquid waste containers. EHS can supply twenty liter plastic buckets with lids for solid waste. Otherwise, paper and other lightweight waste should be double-bagged, and sharps and other bulky waste should be placed in boxes or jars. Needles, pipettes or broken glass placed in bags are a safety hazard. All packages should be leak proof and tightly sealed.

#### 2. **“Mixed wastes” should be separate from other waste:** A mixed waste is one that is a RCRA hazardous waste as well as radioactive. (See instructions on how to fill out the radioactive waste pickup form.) A common example is scintillation cocktail with toluene. The vials containing this liquid should be packaged separately. If labs use a biodegradable or another non-toluene fluor, these should not be mixed with the toluene. Lead is also a RCRA waste, so lead pigs should not be combined with the other solid waste.

If the waste contains any known hazardous constituent, those hazards need to be identified both on the radioactive deletion form and on the waste container (especially for the liquid waste).

#### 3. **Isotopes should not be mixed in single containers, if it can be avoided:** Each isotope has a different half-life and decays out at a different rate. Under the university's NRC license, waste radioactive materials with half-lives shorter than 65 days can be safely disposed after the passage of 10 half-lives, the rest must be packaged for disposal by an outside contractor. Radioactive waste burial sites charge by the cubic foot, so it is an unnecessary expense to have P-32 or I-125 waste mixed with the H-3 and C-14.

#### 4. **Waste containers should not be over-filled:** Jugs that are more than 80 to 90

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percent full are difficult to pour without spilling. Bags and other containers should not be filled to the point that they rupture or are difficult to tie closed. When a container is sufficiently full, a new one should be started.

5. **All containers should be properly labeled with the radiation symbol and the words “CAUTION, RADIOACTIVE MATERIAL”:** In addition, the white EHS isotope stickers, with the users name, the isotope, the amount of radioactivity in that container (in mCi), and the date should be on each container. Each isotope requires its own sticker. Each container should also be labeled indicating any other chemical or physical hazards (for example, “scintillation vials with toluene, flammable” or “sharps”).
6. **Decay calculations should be done before the waste form is filled out:** It is preferred that the activity reported on the waste form reflects the true amounts due to the nature of radioactive decay (especially with isotopes with half lives shorter than 65 days). A separate deletion form is required for decay calculations.
7. **Completely fill out the RADIOACTIVE WASTE PICKUP form(s):** One form goes with each radionuclide. These must accompany the waste, or the waste can't be picked up. Make sure to include all the information requested (see the instructions on filling out the Waste Pickup Form).
8. **Call Environmental Health and Safety to request a pickup:** Information on the kind of waste, how many containers and whose lab it is from should be provided. EHS makes pickup rounds once a week on an assigned day (the day depending on semester schedules). Requests for pickup must be made by 8:00 a.m. on the pickup day. The ones called in while the crew is on their route may or may not be picked up, depending on time restrictions. All waste and paperwork should be ready when the crew arrives. Sometimes tight schedules don't allow time for them to help fill out forms or wait around while someone does it. A good practice is to have the waste ready and do the paperwork before the call for pickup is made. That way the waste can be picked up without delay.

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### [Appendix E. Model Procedures for Handling Radiological Emergencies](#)

#### **A) General Safety Procedures to Handle Spills:**

- 1) For emergency contact during normal working hours, the names and work telephone numbers of the RSO and Principal User are posted on the laboratory placard located outside the main door of each radionuclide work area.
- 2) For contact after regular working hours, the names and home phone numbers of the RSO and Principal User is also posted on the laboratory placard. If the caller dials the EHS phone number after hours (766-3277), a recorded message gives the pager number at which a member of EHS can be reached.
- 3) Alternately, if the caller is on campus and dials 911, the University Police has a call-down list that can be used to locate members of the EHS staff.
- 4) Each workplace where unsealed radioactive materials are used should have access to emergency equipment for handling spills. Spill kits should include the following:
  - Disposable gloves
  - Disposable lab coats
  - Disposable shoe covers
  - Roll of absorbent paper with plastic backing
  - Masking tape
  - Plastic trash bags with twist ties
  - "Radioactive Material" labeling tape
  - Marking pen
  - "Radioactive Material" labeling tags
  - Wipe-test materials
  - Instructions for "Emergency Procedures"
  - Clipboard with paper for completing spill report
  - Pencil or pen
  - Appropriate survey instruments including batteries (for survey meters).

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### B) Minor Spills of Liquids and Solids:

#### 1) Instructions to Workers:

- Notify persons in the area that a spill has occurred.
- Prevent the spread of contamination by covering the spill with absorbent paper. (Paper should be dampened if solids are spilled).
- Clean up the spill, wearing disposable gloves and using absorbent paper.
- Carefully fold the absorbent paper with the clean side out and place in a plastic bag for transfer to a radioactive waste container. Put contaminated gloves and any other contaminated disposable material in the bag.
- Survey the area with an appropriate low-range radiation detector survey meter or other appropriate technique. Check the area around the spill for contamination. Also check hands, clothing, and shoes for contamination.
- If contamination levels cannot be achieved below limits in Tables 6 or 7 of the Radiation Safety Manual, Section III.J. report the incident to the Radiation Safety Officer (RSO) promptly (766-3277) and allow no one to return to work in the area unless approved by the RSO.
- Cooperate with RSO/RSO staff (e.g., investigation of root cause, provision of requested bioassay samples).
- Follow the instructions of the RSO/RSO staff (e.g., decontamination techniques, surveys, provision of bioassay samples, requested documentation).

#### 2) Reminders to RSO:

- *Follow up on the decontamination activities and document the results.*
- *As appropriate, determine cause and corrective actions needed; consider bioassays if licensed material may have been ingested.*
- *If necessary, notify NRC (see 10CFR20.2201).*

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### C) Major Spills of Liquids and Solids:

#### 1) Instructions to Workers:

- Clear the area. If appropriate, survey all persons not involved in the spill and vacate the room.
- Prevent the spread of contamination by covering the spill with absorbent paper (paper should be dampened if solids are spilled), but do not attempt to clean it up. To prevent the spread of contamination, limit the movement of all personnel who may be contaminated.
- Shield the source only if it can be done without further contamination or significant increase in radiation exposure.
- Close the room and lock or otherwise secure the area to prevent entry. Post the room with a sign to warn anyone trying to enter that a spill of radioactive material has occurred.
- Immediately notify the RSO (766-3277) and the principal user. Telephone numbers for work and after-hours are listed on the room placard near the main lab entrance. The Campus Police (911) have an after-hours call list for EHS personnel if the RSO cannot be reached.
- Survey all personnel who could possibly have been contaminated. Decontaminate personnel by removing contaminated clothing and flushing contaminated skin with lukewarm water and then washing with a mild soap.
- Allow no one to return to work in the area unless approved by the RSO.
- Cooperate with RSO/RSO staff (e.g., investigation of root cause, provision of requested bioassay samples).
- Follow the instructions of the RSO/RSO staff (e.g., decontamination techniques, surveys, provision of bioassay samples, requested documentation).

#### 2) Reminders to RSO:

- *Confirm decontamination of personnel. If decontamination of personnel was not fully successful, consider inducing perspiration by covering the area with plastic. Then wash the affected area again to remove any contamination that was released by the perspiration.*
- *Supervise decontamination activities and document the results. Documentation should include location of surveys and decontamination results.*
- *Determine cause and needed corrective actions; consider need for bioassays if licensed material may have been ingested.*
- *If necessary, notify NRC (see 10CFR20.2201).*

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### D) Incidents Involving Radioactive Dusts, Mists, Fumes, Organic Vapors, and Gases:

#### 1) Instructions to Workers:

- Notify all personnel to vacate the room immediately.
- Shut down ventilation system, if possible.
- Vacate the room. Seal the area, if possible.
- Immediately notify the RSO (766-3277) and the principal user. Telephone numbers for work and after-hours are listed on the room placard near the main lab entrance. The Campus Police (911) have an after-hours call list for EHS personnel if the RSO cannot be reached.
- Ensure that all access doors to the area are closed and posted with radiation warning signs, or post guards (trained) at all access doors to prevent accidental opening of the doors or entry to the area.
- Survey all persons who could have possibly been contaminated. Decontaminate as directed by the RSO.
- Promptly report suspected inhalations and ingestions of licensed material to the RSO (766-3277).
- Decontaminate the area only when advised and/or supervised by the RSO.
- Allow no one to return to work in the area unless approved by the RSO.
- Cooperate with RSO/RSO staff (e.g., investigation of root cause, provision of requested bioassay samples).
- Follow the instructions of the RSO/RSO staff (e.g., decontamination techniques, surveys, provision and collection of bioassay samples, requested documentation).

#### 2) Reminders to RSO:

- *Supervise decontamination activities.*
- *Perform air sample surveys in the area before permitting resumption of work with licensed materials*
- *Provide written directions to potentially contaminated individuals about providing and collecting urine, breath, blood, or fecal samples, etc.*
- *Consider need for medical exam and/or whole body count before permitting involved individuals to return to work with licensed material.*
- *Determine cause and corrective actions needed: consider need for bioassays if licensed material may have been ingested. Document incident.*
- *If necessary, notify NRC (see 10CFR20.2201).*

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### E) Minor Fires:

#### 1) Instructions to Workers:

- If you have received proper training and feel comfortable doing so, immediately attempt to put out the fire by approved methods (i.e., fire extinguisher) if other fire hazards or radiation hazards are not present.
- If others are present, notify them to vacate the area, pull the fire alarm and have one individual immediately call 911 and the RSO (766-3277) and the principal user. Telephone numbers for work and after-hours are listed on the room placard near the main lab entrance. The Campus Police (911) have an after-hours call list for EHS personnel if the RSO cannot be reached.
- If no other persons are present and you are unable to extinguish the fire within 30 seconds, pull the fire alarm, leave the building and call 911 immediately.
- Once the fire is out, isolate the area to prevent the spread of possible contamination.
- Survey all persons involved in combating the fire for possible contamination.
- Decontaminate personnel by removing contaminated clothing and flushing contaminated skin for at least 2 minutes with lukewarm water and mild soap.
- In consultation with the RSO, determine a plan of decontamination and the types of protective devices and survey equipment that will be necessary to decontaminate the area.
- Allow no one to return to work in the area unless approved by the RSO.
- Cooperate with RSO/RSO staff (e.g., investigation of root cause, provision of requested bioassay samples).
- Follow the instructions of the RSO/RSO staff (e.g., decontamination techniques, surveys, provision of bioassay samples, requested documentation).

#### 2) Reminders to RSO:

- *Supervise decontamination activities.*
- *If decontamination of personnel was not fully successful, consider inducing perspiration by covering the area with plastic. Then wash the affected area again to remove any contamination that was released by the perspiration.*
- *Consult with fire safety officials to assure that there are no other possibilities of another fire starting.*
- *Determine cause and needed corrective actions; consider need for bioassays if licensed material may have been ingested. Document incident.*
- *If necessary, notify NRC (see 10CFR20.2201).*

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### F) Accidents Involving Medical Emergencies:

#### 1) Instructions to Workers:

- Take care of medical emergencies first. Call 911 immediately.
- Decontamination can occur when the victims are in stable condition.
- Take steps to prevent the spread of contamination, including: shutting off ventilation system if there is a possibility of air-borne contamination; preventing ingress into the contaminated area by any unnecessary persons and; keeping contamination localized.
- Notify the RSO (766-3277) and the principal user responsible for the workplace as soon as possible. Telephone numbers for work and after-hours are listed on the room placard near the main lab entrance. The Campus Police (911) have an after-hours call list for EHS personnel if the RSO cannot be reached.
- Any loss of radioactive material must be reported to EHS (766-3277) as soon as possible after the loss is noted.
- Cleanup may proceed according to appropriate procedures outlined above.
- See the University of Wyoming Chemical Hygiene Program for University policy on medical examinations and consultation.

#### 2) Reminders to RSO:

- *Coordinate activities with other EHS personnel, and with local emergency responders.*
- *Assist the emergency response personnel with surveys for contamination of their protective clothing and equipment after the victim is removed. Supervise decontamination activities.*
- *Do not allow anyone to enter the radiation area until a thorough evaluation and survey are performed to determine the extent of the damage to the licensed material use and storage areas.*
- *Consider bioassays if licensed material may have been ingested. Document incident.*
- *If necessary, notify NRC (see 10CFR20.2201).*

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### G) Fires, Explosions, or Major Emergencies:

#### 1) Instructions to Workers:

- Take care of medical emergencies first. Decontamination can occur when the victims are in stable condition.
- If there is fire or radiological release, notify all persons in the area to leave, pull the fire alarm, leave the area.
- Call 911 immediately.
- While on the phone with 911 emergency response, inform them where radioactive materials were stored or used; inform them of the best possible entrance route to the area, as well as any precautions to avoid exposure or risk of creating radioactive contamination.
- Notify the RSO (766-3277) and other facility safety personnel.
- Check for contamination of individuals. If contamination is found or suspected, decontaminate as quickly as possible taking into account the amount of contamination, type of radiation and the possibility of internal contamination.
- Cooperate with RSO/RSO staff (e.g., investigation of root cause, provision of requested bioassay samples).
- Allow no one to return to work in the area unless approved by the RSO.
- Follow the instructions of the RSO/RSO staff (e.g., decontamination techniques, surveys, provision of bioassay samples, requested documentation).
- See the University of Wyoming Chemical Hygiene Program for University policy on medical examinations and consultation.

#### 2) Reminders to RSO:

- *Coordinate activities with other EHS personnel, and with local fire department.*
- *Consider contacting the Wyoming Radiological Response Team ((307)-777-4900) for assistance.*
- *Assist the emergency response personnel with surveys for contamination of their protective clothing and equipment after the fire is extinguished. Supervise decontamination activities.*
- *Once the fire is extinguished, do not allow anyone to enter the radiation area until a thorough evaluation and survey are performed to determine the extent of the damage to the licensed material use and storage areas.*
- *Consider bioassays if licensed material may have been ingested. Document incident.*
- *If necessary, notify NRC (see 10CFR20.2201).*

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### Appendix F - NUCLEAR GAUGE (SEALED SOURCE) SAFETY PLAN

#### I. General

- A. This Safety Plan covers the procedures for the safe and proper use and possession of radioactive material as contained in portable moisture/density gauges used to measure soil and other materials. When handled in accordance with this plan, exposures to the licensee's employees or the general public will be as low as reasonably achievable.

#### II. Organization and Responsibilities

- A. Nuclear Regulatory Commission (NRC) Materials License:
1. The University of Wyoming is under license by the NRC to use limited quantities of radioactive materials, both as unsealed and sealed sources. As pertaining to sealed sources used in nuclear gauges, the license specifies the following:
    - a. Sealed sources associated with or incorporated into measuring instruments for field experiments and projects may be used anywhere in the State of Wyoming provided such use is approved by the Radiation Safety Committee.
    - b. Licensed material shall be used by, or under the supervision of, individuals designated by the Radiation Safety Committee.
    - c. Sealed sources: shall not be opened by the licensee.
    - d. All sealed sources requiring leak testing according to section 31.5(c) of 10 CFR will be leak tested by EHS at least every six months.
    - e. In the absence of a certificate from a transferor indicating that a leak test has been made within 6 months prior to the transfer, a sealed source or detector cell received from another person shall not be put into use until tested.
    - f. Sealed sources need not be leak tested if they are in storage and are not being used. The sources shall be leak tested if taken out of storage for use or transfer to another person.
    - g. The licensee is authorized to transport licensed material only in accordance with the provisions of 10 CFR Part 71, "Packaging and Transportation of Radioactive Material."

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- h. The licensee shall conduct a physical inventory every 6 months to account for all sources and/or devices received and possessed under the license.
- i. Each portable nuclear gauge shall have a lock or outer locked container designed to prevent unauthorized or accidental removal of the sealed source from its shielded position. The gauge or its container must be locked when in transport, storage, or when not under the direct surveillance of an authorized user.

### B. Radiation Safety Committee

- 1. For a full description of the membership and duties of the Radiation Safety Committee, refer to the UW Radiation Safety Manual. As they pertain to nuclear gauging devices, this committee has the following duties:
  - a. Establish criteria for evaluating potential users and uses of ionizing radiation.
  - b. Develop procedures and criteria for training and testing each category of worker, and for evaluating the effectiveness of the training program.
  - c. Periodically review and update the Radiation Safety Program, and periodically distribute information in order to ensure compliance with the program and applicable regulations.
- 2. The committee may delegate some of its functions to the RSO, EHS staff, or to subcommittees, but is responsible for the ultimate performance of these functions.

### C. Radiation Safety Officer (RSO)

- 1. For a full description of the qualifications and duties of the RSO, refer to the UW Radiation Safety Manual. Pertaining to nuclear gauge devices, the RSO shall have the following duties:
- 2. To ensure that all terms and conditions of the license are being complied with and that the information contained is up-to-date and accurate.
- 3. To ensure that the equipment is inventoried and leak-tested every six months, as required by the license.

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4. To ensure that the equipment is only used by authorized operators, and that they receive the training in order to use the equipment in accordance with all relevant regulations.
  5. To issue the proper monitoring devices and see that users wear them.
  6. To maintain records as required by the license and regulations, including:
    - a. Personnel monitoring
    - b. Leak tests
    - c. Training
    - d. Inventory
  7. To ensure that all equipment is properly secured against unauthorized removal at all times.
  8. To serve as a point of contact and give assistance in case of an emergency such as equipment damage, theft, or fire, and to notify the proper authorities in case of an emergency.
  9. To arrange proper training for authorized users.
  10. To post all required signs and notices at gauge storage locations.
  11. To order, receive or ship all nuclear gauges by commercial carrier, ensuring all applicable regulations are followed.
- D. Authorized Users
1. Principal User is responsible for:
    - a. Maintenance of the device, including keeping files on operating manuals, calibrations and repairs.
    - b. Deciding what persons can use the device, and seeing that these persons obtain monitoring and training and/or authorization from the RSO.
    - c. Providing training for authorized users in the field operation and maintenance of the device.
  2. All Authorized Users should:

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- a. Know the operating instructions
- b. Complete a training course: given or approved by the RSO and know the health and safety rules
- c. Use safety equipment and monitoring devices properly
- d. Know emergency reporting procedures.

### III. Operating Procedures

- A. The operator will exercise suitable control over the gauge at all times. At no time is it to be left unattended or in the possession of an unauthorized person.
- B. When not being used for field measurements, the gauge will be locked and returned to its storage/transportation case.
- C. When testing is complete, the gauge will be returned to its permanent storage location as soon as possible.
- D. When using the equipment, the operator will wear the personal monitoring device assigned. When the operator is not using the equipment, the monitoring device will be kept in a radiation-free, low heat area.
- E. The operator should always use the instrument for its intended purpose.
- F. While the equipment is in the operator's possession, the operator will have:
  1. A copy of this Safety Plan
  2. A copy of the Gauge Operating Manual
  3. A copy of the current leak test certificate

### IV. Storage

- A. Posting
  1. Signs with the approved radiation symbol are placed on storage rooms as follows:
    - a. **CAUTION - RADIOACTIVE MATERIAL** for rooms with >10 control units
    - b. **CAUTION - RADIATION AREA** where dose equivalent > 5

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millirem/hr

- c. **CAUTION - HIGH RADIATION AREA** where dose equivalent > 100 millirem/hr

### B. Security

- 1. Two levels of locks are required to prevent unauthorized access to radioactive devices.

### C. Safety

- 1. Nuclear gauging devices should be stored no closer than 15 feet from the nearest workstation.
- 2. Members of general public shall not receive an equivalent dose more than: 2 millirem/hour or 100 millirem/year.

### D. Temporary Storage

- 1. If the instrument will not be returned to the permanent storage area at the end of the day, the temporary storage location should follow the same rules for posting, security and safety.
- 2. The NRC must be notified if temporary storage will be longer than 30 days.

## V. Check-Out Procedures

A. For security and safety reasons, sealed radioactive sources put into storage by University of Wyoming departments are located in room 138 of the Regulated Materials Management Center (RMMC) at 751 North 19th Street. This room is specifically designed and labeled for storage of radioactive materials and is kept locked at all times. All sealed radioactive sources at UW are inventoried and leak tested every six months and the records are kept by: Environmental Health and Safety (EHS). In order to ensure that these sealed sources are only released to persons who are authorized to handle them, the following checkout procedures must be used.

- 1. Call the RMMC at 766-3696, as far in advance as practical, to make arrangements.
- 2. Bring some form of identification (and a letter from the authorized user, if necessary).
- 3. Wear the film badge issued to you by EHS. If you do not have a film

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badge you must first go to Merica Hall room 312 to be issued one.

4. When you arrive at the RMMC, sign a checkout form for sealed radioactive devices, giving the source identification, date checked out and the estimated date of return to the RMMC. Your signature will be compared to the signature page for that device.
5. No source should be checked out without a proper shipping container and a copy of the operator's manual. A copy of the emergency response information and the proper shipping papers will be issued, and must be located on the driver's door or on the seat next to the driver when transporting the device by private vehicle.
6. When not in use the radioactive device must be kept securely locked in its case and otherwise locked (in a vehicle or room) so that unauthorized personnel cannot gain access. The storage area must be posted with one or more **CAUTION RADIOACTIVE MATERIAL** signs.
7. When finished with the source, you should make arrangements to have someone receive it at the RMMC. **DO NOT SIMPLY DROP IT OFF UNATTENDED!** The device has to be checked in and returned to the storage room by authorized EHS personnel.
8. For instruments not stored at the RMMC, a check-out log should be attached to the storage cabinet, including the serial number of the gauge, operator checking it out, date checked out, destination, estimated return date, and actual date of return.

## VI. Transportation

### A. Labeling

1. All CPN and Troxler carrying cases should have the following labels and markings:
  - a. YELLOW II label:
  - b. Two on opposite sides, describing the radioactive material type, quantity and transport index (TI):
    - (1) YELLOW II is applicable if the dose rate on the surface of the package is 0.5 to 5.0 mrem/hr.
    - (2) The TI is the dose rate in mrem/hr at one meter from the surface of the package.

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(3) Vehicles in which YELLOW II labeled cases are transported do not need to be placarded.

c. Nomenclature and package description:

(1) R.Q., RADIOACTIVE MATERIAL, SPECIAL FORM. N.O.S., UN 2974

(2) USA DOT 7A, TYPE A PACKAGE

d. DANGER - CARGO ONLY label, if transported by air:

### B. Security

1. Transport the nuclear device only in the manufacturer's carrying case (Type A package)
2. Locate the case as far away from passengers as possible.
3. In enclosed vehicles (car, van) the vehicle should be locked while moving.
4. In the back of a pickup truck, the case should be securely attached, blocked and braced.
5. When left in the vehicle, the instrument should be locked. Ignition keys should be removed and the driver's compartment locked.

C. The following documentation, carried at all times, should be accessible to the driver (on the vehicle seat or side pocket, not in instrument carrying case).

1. Shipping papers or bill of lading for each gauge
2. Type A Package certificate (provided by manufacturer)
3. Sealed Source Certificate (provided by manufacturer)
4. DOT Emergency Procedures.

### D. Reciprocity

E. Ordinarily, licensees are not allowed to use portable nuclear gauging devices outside of their licensed territories without permission of the state agency or USNRC region in which they intend to work. Reciprocity is granted for periods up to 180 calendar days. If this limit is exceeded, a Radioactive Materials License for that state or USNRC jurisdiction is required.

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Requirements to obtain reciprocity include:

1. Approval by the UW Radiation Safety Committee
2. At least 5 days written notification: of intent to transport and use gauge, sent by the RSO to the affected jurisdiction.
3. Copy of the latest leak test for the gauge.
4. Temporary address of use/storage area.

### VII. Maintenance Procedures

- A. Periodic maintenance includes cleaning the gauge. The operator will have received proper instruction on how to clean the gauge and will wear the monitoring device assigned.
- B. No maintenance will be performed in which the radioactive source is removed from the gauge. The gauge will be returned to the manufacturer or an approved service center for this type or service.

### VIII. Training

- A. All operators shall either complete the training course provided by the University of Wyoming RSO, a manufacturer's training course, or some other course approved by the RSO.
- B. All operators shall be trained: in the operation and maintenance of the device by the Principal User of the device, or a qualified Independent User designated by the Principle User.

### IX. Incidents

- A. Physical Damage:
  1. If any moving equipment is involved: stop its movement, until the extent of contamination, if any, can be determined.
  2. Partition off the area for a distance of 15 feet around the damaged instrument.
  3. Visually inspect the gauge to determine the extent of the damage to the source, source housing and shielding, keeping in mind minimizing personal radiation exposure.
  4. At the earliest possible time, when the situation is under control,

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contact the RSO at 766-3277. Never leave the instrument unattended. Describe the situation and follow the instructions of the RSO.

- B. Theft or Loss:
  - 1. Notify the RSO at 766-3277 as soon as possible; who will immediately notify the NRC, the gauge manufacturer and the proper authorities as directed by the NRC.
  
- C. The RSO shall notify the NRC:
  - 1. Immediately after:
    - a. an accident involving possible dispersment of radioactive material
    - b. theft or loss of radioactive material
  
  - 2. Within 24 hours of:
    - a. an exposure to an individual to 5 rem or more
    - b. an accident resulting in the loss of one day or more operation
    - c. damage to property in excess of \$1,000
  
  - 3. Within 30 days of:
    - a. exposure of an individual in excess of the allowable dose of 1.27 rem per quarter.

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### Appendix G. X-RAYS AND OTHER IONIZING RADIATION DEVICES

#### I. Rules, Regulations and Responsibilities

- A. All uses of ionizing radiation at the University of Wyoming (UW), whether from radioactive materials or radiation devices, must be approved by the University Radiation Safety Committee (RSC) and the Radiation Safety Officer (RSO). See the UW Radiation Safety Manual, Operating Procedures for details. The application to use ionizing radiation devices at the University of Wyoming is available from Environmental Health & Safety (EHS).
- B. In Wyoming, the Department of Labor, Occupational Health & Safety Division, determines safe practices for sources of ionizing radiation that are not licensed by the Nuclear Regulatory Commission (NRC). This includes electron microscopes as well as analytical and medical x-ray devices.
  - 1. Wyoming has adopted the federal regulations on ionizing radiation as published by the Occupational Safety and Health Administration (OSHA) in 29 CFR 1910.1096.
  - 2. These regulations are similar, but not identical to those published by the NRC in CFR Title 10. If a work area has both radioactive materials and radiation producing devices, the stricter of the two regulations shall apply.
- C. Individuals who use ionizing radiation on human subjects must be licensed by the State of Wyoming Board of Radiologic Technologists.
  - 1. Procedures involving ionizing radiation on humans shall be under the direction of a practitioner licensed by the State of Wyoming.
  - 2. Projects that involve the participation of human subjects require approval or exemption from the University Institutional Review Board (IRB).
- D. The Food and Drug Administration (FDA), Department of Health and Human Services, regulates the design and performance standards for ionizing radiation emitting products, including diagnostic and cabinet X-ray devices. Specifications are codified in 21 CFR Part 1020.
- E. Proper management of ionizing radiation devices and their operators is the responsibility of the authorized Principal User, under whose permit the device is being used. It is the responsibility of each member of the

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laboratory to maintain safe use of the device(s) in their area.

- F. Ionizing radiation devices shall be certified initially and periodically (as recommended by the manufacturer) thereafter by a qualified expert. Service records must be maintained and available for inspection. Additionally, radiation exposure surveys and surveys following repairs or changes are to be coordinated through the RSO. The Principal User shall register all ionizing radiation devices with the RSO to ensure compliance with these inspection requirements.

### II. Occupational Dose Limits

- A. The limits for occupational exposure from ionizing radiation devices at UW are listed in Table 1 below.
  - 1. Dose limits notwithstanding, it is UW policy to use procedures and engineering controls based upon practical, sound, radiation protection principles to achieve occupational doses and doses to the public that are as low as reasonably achievable (ALARA).
  - 2. If an employee's dose exceeds the ALARA limits for the month (column 3), they will be requested to review procedures for ways to reduce future exposures.
  - 3. If occupational doses from radiation devices exceed the monthly average limits (column 2), the Radiation Safety Officer will conduct an investigation into the probable cause of the dose, possible exposure to non-monitored personnel or the public, and methods to reduce future exposures.
  - 4. The RSO must notify State and Federal authorities of any radiation exposure in excess of quarterly dose limits (column 1).
  - 5. No radiation producing device shall produce radiation in such a manner as to create in any non-controlled area:
    - a. Radiation levels which could result in a dose in excess of 2 millirem (0.002 rem) in any one hour; or
    - b. Radiation levels which, if an individual were continuously present in the area, could result in a dose in excess of 100 millirem (0.100 rem) in one year.

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**Table 1**  
**Occupational Dose Limits (from 29 CFR 1910.1906)**  
**and University of Wyoming monthly ALARA limits**

<u>Body Part</u>	<u>Col. 1 Calendar Quarter</u>	<u>Col.2 Monthly Average</u>	<u>Col.3 Monthly ALARA</u>
<b>ADULTS:</b>			
Dose to Whole Body: Head and trunk; active blood-forming organs; lens of eyes; or gonads	1.25 rem	0.416 rem	0.010 rem
Dose to Hands and forearms; feet and ankles	18.75 rem	6.25 rem	0.150 rem
Skin of whole body	7.5 rem	2.5 rem	0.060 rem

**MINORS (under 18):**

No employee under 18 years of age shall receive in any calendar quarter a dose in excess of 10 percent of the adult limits listed above.

**DECLARED PREGNANT WOMEN**

The exposure to an embryo/fetus during the entire gestation period, due to the occupational exposure of a declared pregnant woman, shall not exceed 0.5 rem. Exposure shall not vary substantially above an average uniform monthly exposure rate so as to satisfy this limit (approximately .05 rem/month).

**III. Radiation Device Acquisition (Purchase or Transfer)**

- A. Laboratories wishing to acquire an ionizing radiation device shall first obtain a permit for the device from the Radiation Safety Committee and permission from the RSO. This includes purchases as well as transfers of devices from other labs, departments or institutions.
- B. The RSO shall evaluate the health and safety implications of each purchase and ensure operating personnel can operate the equipment in a safe manner when the equipment arrives.
- C. These devices may be delivered to the approved facility as long as prior permission has been received from the RSO.

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### IV. Radiation Protection Practices (Training, Monitoring and Shielding)

#### A. Training.

1. Users of ionizing radiation devices shall be appropriately trained in radiation safety and equipment operation and applicable Federal and State Regulations prior to beginning work with the device. This training must be provided by or approved by the RSO.
2. All individuals working in or frequenting any portion of a controlled radiation area shall be informed of the occurrence of radiation in the area; and shall be instructed in the safety problems associated with exposure to such radiation and in provisions, precautions or devices to minimize exposure.

#### B. Personnel Monitoring (Dosimetry).

1. Dosimetry is required for:
  - a. Each adult employee who enters a controlled area who is likely to receive a dose in any calendar quarter in excess of 25 percent of the applicable limits in Table 1;
  - b. Each employee under 18 years of age who enters a controlled area who is likely to receive a dose in any calendar quarter in excess of 5 percent of the applicable adult limits in Table 1; and
  - c. Each employee who enters a high radiation area.
2. Whole body dosimeters, as well as extremity rings or area monitors, may be issued to personnel using ionizing radiation devices, as determined by the RSO, in order to demonstrate that exposures to personnel and public are kept as low as reasonably achievable.
3. If dosimetry is required, employees shall be advised of reports of radiation exposure, which employees may request pursuant to the regulations.

#### C. Surveys.

1. Unless specifically exempted by the Radiation Safety Committee or the Radiation Safety Officer, each Principal User using radiation-producing devices shall have a functioning and calibrated survey instrument appropriate to the type and level of ionizing radiation used.

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2. Radiation surveys shall be performed:
  - a. Upon installation of the equipment;
  - b. At least once every 12 months thereafter;
  - c. Following any change in the initial arrangement, number or type of local components in the system;
  - d. Following any maintenance requiring the disassembly or removal of a local component in the system;
  - e. During the performance of maintenance and alignment procedures, if the procedures require the presence of a primary x-ray beam when any local component of the system is disassembled, or removed;
  - f. Any time a visual inspection of the local components in the system reveals an abnormal condition; and
  - g. Whenever personnel monitoring devices show a significant increase over the previous monitoring period, or when the readings approach occupational dose limits.
  
- D. Shielding.
  1. The ionizing radiation device shall be located or shielded so that no radiation levels exist in any surrounding non-controlled area that could result in a dose to an individual present in excess of 100 mrem per year or 2 mrem in any 1 hour.
  2. The Radiation Safety Committee may require the use of other special equipment or devices. This may include special shielding, alarms and warning devices, and other such apparatus.

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### V. Signs and Posting

- A. The following signs or labels, carrying the approved radiation symbol, shall be conspicuously posted as indicated.
  - 1. **CAUTION -RADIATION AREA** - for accessible areas in which a major portion of the body could receive a dose in excess of 5 millirem in any 1 hour or in any 5 consecutive days a dose in excess of 100 millirem.
  - 2. **CAUTION - HIGH RADIATION AREA** - for accessible areas in which a major portion of the body could receive a dose in excess of 100 millirem in any 1 hour.
  - 3. **CAUTION - X-RAY EQUIPMENT** - for facilities containing x-ray equipment, but not meeting any of the above dose criteria.
- B. Environmental Health & Safety shall also provide Emergency Notification placards that include telephone numbers for the Principal User, RSO and/or other emergency contact designee.
- C. Each authorized user to whom this section applies shall conspicuously post a current copy of this manual and any other applicable operating procedures, or shall keep such documents available for examination by employees upon request.

### VI. Security and Storage

- A. Each laboratory must assure security of ionizing radiation devices. This requires either constant surveillance or locking of laboratory doors and/or devices. All laboratory areas in which radiation devices are used shall have a sign displayed on all entrances as indicated above. Operating keys shall not be kept in the device when the device is not in active use.

### VII. Special Rules for Medical (Human Use) Radiation Devices

- A. Under University Regulation 2.h, research that involves the participation of human subjects requires approval from the University Institutional Review Board (IRB). The Principal User applicant must submit a copy of the IRB approval to the Radiation Safety Committee before human-use radiation devices can be approved and before the ionizing radiation device(s) can be purchased.
- B. The Wyoming Board of Radiologic Technologists must first license persons who apply ionizing radiation to human subjects. Contact the RSO if you require assistance with licensing radiologic technologists or technicians.

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- C. The use of ionizing radiation on humans shall be under the supervision of a practitioner licensed by the State of Wyoming. The practitioner shall provide a signed authorization only after verifying that only a licensed radiologic technician who is competent in the safe use of the device will operate the radiation device.
- D. Protection for Radiation Study Participants.
  - 1. Participants in research that involves exposure to ionizing radiation must be informed about the risks.
    - a. All participants must sign an informed consent form prior to being exposed to radiation. The operator must confirm that this has been done.
    - b. If the Principal User application for authorized use of ionizing radiation involves human subjects, it must include an example of the informed consent form and questionnaire that will be used.
  - 2. Pregnancy is of special concern and shall be addressed, if the study includes females of childbearing age.
    - a. Pregnant persons shall not be used as participants in studies involving exposure to ionizing radiation. A urine or blood (preferred) pregnancy test must be performed, if the participant is female and within childbearing age.
    - b. The informed consent form shall include information regarding the hazards of radiation exposure to the developing embryo/fetus. The Operator shall document the gender of the participant and, if female, whether or not the subject has been tested for pregnancy.
    - c. If pregnancy cannot be ruled out, the subject shall be eliminated from the radiation study.
  - 3. A record must be maintained of the name, gender and age of participants, the dates and types of scans, and the estimated participant dose.
  - 4. Before being used as a participant, it shall be determined whether a person has been exposed to radiation from any other research project in the past twelve months. Study participants shall not receive a radiation dose above background exceeding 100 mrem in 1 calendar year.

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5. Any questionnaires, consent forms and results from radiation tests are by definition medical records and therefore protected under OSHA and/or the Health Insurance Portability and Accountability Act of 1996 (HIPAA).
  6. These participant protection rules apply to all persons exposed for the purposes of the research project, including not only test subjects, but also department employees, authorized users or other volunteers who are used as subjects only for operator training.
- E. The authorized Principal User is responsible for maintaining the ionizing radiation device in the condition that it was installed, and consulting with the RSO on any changes in the device or facility design, which may affect radiation exposure to subjects, the operators or other employees working in the area.
- F. No one except the study participant, the responsible physician, the operator or operators-in-training may be present in the radiation device facility during the radiation procedure without prior RSO approval.
- G. Operators are not authorized to hold or support any portion of the research participant's body during a radiation exposure.

### VIII. **Special Rules for Analytical Cabinet X-ray Devices**

- A. Analytical x-ray devices utilize x-rays or gamma radiation to determine the elemental composition or examine the microstructure of materials using diffraction or fluorescence analysis.
- B. Equipment Requirements
1. The design and performance standards in this section are as recommended by the Conference of Radiation Control Program Directors (CRCPD).
  2. Each x-ray unit must have a safety device (interlock) that prevents the entry of any portion of an individual's body into the path of the active primary x-ray beam.
  3. The x-ray unit must also have a discernible indication of x-ray tube "on-off" status; shutter "open-closed" status; and an easily visible warning light labeled with the words "**X-RAY ON**", or similar words. Equipment should have fail-safe characteristics in the warning devices.
  4. Any unused ports shall be secured in the closed position, in a manner that will prevent casual opening.

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5. All analytical x-ray equipment shall be labeled near any switch that energizes an x-ray tube with a readily discernible sign bearing the radiation symbol and the words: **“Caution Radiation - This equipment produces radiation when energized.”**
  6. X-ray units shall be equipped with a shutter for each port on the radiation source housing that cannot be opened unless a collimator or a coupling has been connected to the port.
    - a. Each source housing shall be equipped with an interlock that shuts off the tube if it is removed from the radiation source housing, or if the housing is disassembled.
    - b. Each radiation source housing or port cover should be constructed so that, with all shutters closed, the radiation dose measured at a distance of 5 cm from its surface is not in excess of 2.5 mrem in one hour.
  7. Each x-ray generator shall be supplied with a protective generator cabinet that limits leakage radiation measured at a distance of 5 cm from its surface such that it is not capable of producing a dose in excess of 0.25 mrem in one hour.
- C. Operating Requirements
1. Normal operation procedures shall be written and available to all analytical x-ray equipment workers. No individual shall be permitted to operate analytical x-ray equipment in any manner other than that specified in the procedures unless such individual has obtained the written approval of the RSO.
  2. No individual shall bypass a safety device or interlock, unless such individual has obtained the written approval of the RSO. Such approval shall be for a specified period of time. When a safety device or interlock has been bypassed, a readily discernible sign bearing the words **“Safety Device Not Working”**, or similar words, shall be placed on the radiation source housing.
  3. Except as described in the previous paragraph, no operation involving removal of covers, shielding materials, or tube housings, or modifications to shutters, collimators, or beam stops shall be performed without ascertaining that the tube is off and will remain off until safe conditions have been restored. The main switch, rather than interlocks, shall be used for routine shutdown in preparation for repairs.

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4. If the x-ray device contains a radioactive source, replacement, leak testing, or other maintenance or repair procedures shall be conducted only by individuals specifically authorized under the University's NRC Byproduct Materials License.

### D. Personnel Requirements

1. Personnel dosimeters (finger or wrist dosimeters) shall be used by:
  - a. Operators of 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.
2. EHS Staff will survey analytical x-ray devices regularly.