

**Radioactive Materials Safety Plan**

I.	<a href="#">Purpose and Scope</a>	4
II.	<a href="#">Organization and Responsibilities</a>	4
A.	<a href="#">Radiation Safety Committee</a>	4
B.	<a href="#">Radiation Safety Officer</a>	5
C.	<a href="#">Radiation Users</a>	6
III.	<a href="#">Exposure Control and Emergency Procedures</a>	7
A.	<a href="#">Equivalent Dose Limits</a>	7
B.	<a href="#">Personal Monitoring</a>	9
C.	<a href="#">Internal Exposure Monitoring</a>	10
1.	<a href="#">Urine Samples</a>	10
2.	<a href="#">Thyroid Scans</a>	10
D.	<a href="#">Air Monitoring of Radionuclides</a>	12
E.	<a href="#">Classification of Workplaces</a>	12
F.	<a href="#">Handling, Labeling, Transporting, and Storing Radioactive Materials</a>	17
G.	<a href="#">Methods and Frequencies for Conducting Workplace Surveys</a>	18
H.	<a href="#">Contamination Control Practices</a>	21
I.	<a href="#">Decontamination</a>	23
J.	<a href="#">Emergency Procedures for Radiation Accidents and the Loss of Radioactive Material</a>	25
K.	<a href="#">Use of Neutron and Alpha Emitters and Radionuclides Which Decay by Spontaneous Fission</a>	25
L.	<a href="#">Leak Testing of Sealed Sources</a>	26

<u>IV.</u>	<u>Operating Procedures</u> -----	26
A.	<u>Program Applications and Approvals</u> -----	26
B.	<u>Acquisition and Transfer of Radiation Sources</u> -----	27
C.	<u>Security Over Licensed Materials</u> -----	27
D.	<u>Physical Inventories of Radioactive Materials</u> -----	28
E.	<u>Training and Experience of Personnel in Controlled or Restricted Areas</u> -----	28
F.	<u>Disposal of Radioactive Wastes</u> -----	31
G.	<u>Closing Radioactive Accounts</u> -----	31
H.	<u>Special Requirements for Administering Radionuclides to Animals</u> -----	31
<u>V.</u>	<u>Record Requirements</u> -----	33
A.	<u>Authorizations and Qualifications</u> -----	33
B.	<u>Inventories and Disposals</u> -----	33
C.	<u>Surveys and Assays</u> -----	33
D.	<u>Exposures</u> -----	33
E.	<u>Training</u> -----	33
<u>Appendix A</u>	<u>- Documents Available from the RSO and RSC Member List</u> -----	34
<u>Appendix B</u>	<u>- Radiotoxicity Hazard From Absorption Into the Body</u> -----	35
<u>Appendix C</u>	<u>- Isotope-specific information used for radiation protection</u> -----	36
<u>Appendix D</u>	<u>- Procedures for the Safe and Correct Disposal of Radioactive Waste</u> -----	37
<u>Appendix E</u>	<u>- Procedures for Handling Radiological Emergencies</u> -----	38

<a href="#"><u>Appendix F - NUCLEAR GAUGE &amp; SEALED SOURCE SAFETY PLAN</u></a> -----	46
I. <a href="#"><u>General</u></a> -----	46
II. <a href="#"><u>Organization and Responsibilities</u></a> -----	46
III. <a href="#"><u>Operating Procedures</u></a> -----	49
IV. <a href="#"><u>Storage</u></a> -----	50
V. <a href="#"><u>Check-Out Procedures</u></a> -----	51
VI. <a href="#"><u>Transportation</u></a> -----	52
VII. <a href="#"><u>Maintenance Procedures</u></a> -----	54
VIII. <a href="#"><u>Training</u></a> -----	54
IX. <a href="#"><u>Emergency Procedures</u></a> -----	54

## I. Purpose and Scope:

- A. This Radioactive Materials Safety Plan provides radiation protection guidelines that meet the conditions of the University of Wyoming's broad-scope byproduct materials license with the United States Nuclear Regulatory Commission (NRC) and other applicable regulations, so that ionizing radiation sources can be used without endangering the health and safety of workers, students or the general public.
- B. This plan applies only to of 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. Rationale

The Committee is required by the NRC for institutions such as the University of Wyoming operating under a type-A broad scope byproduct (radioactive materials) license as a means for managerial control over licensed activities.

#### 2. Functions

The Committee shall develop, administer and periodically review policies and procedures to assure control of procurement and use of radioactive materials, and enforce the radiation safety program by advising and directing personnel regarding the NRC and/or license provisions. Some of the Committee's functions may be delegated to the Radiation Safety Officer or to subcommittees.

#### 3. Composition

The Committee shall consist of the Associate Vice President for Research, the Radiation Safety Officer/Health Physicist, at least one administrative representative appointed by the Vice President for Administration, and at least one technical representative from each college, group or activity using ionizing radiation sources under the University's license. Appointments will be for a one-year term. Administrative responsibility is assigned to the Vice President for Research. A list of the current members of the Radiation Safety Committee appears in [Appendix A](#).

#### 4. The rationale and functions of the committee are further described in [University Regulation 1-2, section 3.J](#). and in the University [Radiation Safety Committee Control Functions and Administrative Procedures](#) manual, available from the

Radiation Safety office.

5. The duties and responsibilities of the Radiation Safety Committee shall include, but are not limited to, the following:
    - a. Meet as often as necessary to conduct business, but not less than quarterly
    - b. Conduct periodic audits of the radiation safety program reviewing records, written safety procedures, and results of inspections performed by the NRC, the RSO and RSO staff to ensure the adequacy of the 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 this Radioactive Materials Safety Plan and other radiation safety information as necessary to ensure adequate health physics practices, program implementation, and compliance with applicable regulations.
- B. Radiation Safety Officer
1. The Radiation Safety Officer (RSO) is the person identified on the NRC byproduct materials license as having the radiation protection training, experience and resources sufficient to perform the duties required by this position.
  2. 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.
  3. The RSO serves as a voting member of the Radiation Safety Committee and performs the routine duties delegated by the committee to assure compliance with NRC license conditions, state and federal regulations.
  4. The responsibilities assigned to the RSO or RSO staff include:
    - a. Surveillance of overall activities involving ionizing radiation, including routine 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. Furnish consulting services on all aspects of radiation protection to personnel at all levels of responsibility.
- d. 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. Package and ship all radioactive material leaving the institution in accordance with NRC and DOT regulations.
- e. Distribute and process area and personal 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.
- f. 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 and as required by changes in procedures, equipment and regulations, etc.
- g. Supervise and coordinate the radioactive waste disposal program, including effluent monitoring and maintenance of waste storage and disposal records.
- h. Store radioactive materials not in current use.
- i. Perform leak tests on sealed sources as required.
- j. Calibrate portable radiation survey instruments as required.
- k. Maintain an inventory of radiation devices and radioisotopes at the institution. Limit the quantity of radionuclides at the institution to the amounts authorized by the NRC license.
- l. Immediately, without the need of prior approval from senior officials or the offending investigator or department, terminate any activity involving ionizing radiation that is either in violation of applicable regulations or a threat to health or property.
- m. Supervise decontamination and recovery operations.
- n. Maintain other records not specifically designated above, as required by 10 CFR 30.51 or 29 CFR 1910.1096.

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

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.

1. **Principal Users** are persons with faculty or Principal Investigator status, and/or 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 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.
2. **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).
3. **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.
4. **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 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](#). (The dose limits for X-rays are covered in Appendix G.)
2. ALARA

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). If an employee's dose exceeds the ALARA limits for the month (column 3) they should review procedures for ways to reduce future exposures. If occupational doses exceed the monthly average (column 2) the Radiation Safety Officer will investigate 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 rem	416 mrem	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 rem	4.16 rem	100 mrem
Eye dose equivalent	15 rem	1.25 rem	30 mrem
Shallow dose equivalent to skin or any extremity	50 rem	4.16 rem	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

3. 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 rem/month).

4. 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

Controlled areas are any area where equivalent doses may exceed 100 millirem in one year or 2 millirem in one hour or areas in which radioactive materials are used or stored in combined quantities equal to ten times or more of the activities for the radionuclides from column 3, [Appendix C](#). 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 or very high radiation area.
- e. Any other situation deemed appropriate by the RSO

2. Personal and area monitors are provided by the RSO. They are usually exchanged monthly, unless longer wear periods are specified by the RSO. The new badges are sent to a contact person for distribution and the previous month's badges are returned to the RSO. They are sent to a contractor who is certified by the National Voluntary Laboratory Accreditation Program (NVLAP) 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.

C. [Internal Exposure Monitoring \(Bioassay\)](#)<sup>1</sup>

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)<sup>2</sup> for ingestion and inhalation, and minors or declared pregnant women likely to receive in 1 year a committed effective

---

<sup>1</sup> See Nuclear Regulatory Commission Regulatory Guide 8.29

<sup>2</sup> Appendix C, column 5, or Table 1 of appendix B to 10 CFR 20.1001-20.2401)

dose equivalent in excess of 50 mrem. Use of respiratory protection must be approved by the RSO. When such protection is required, bioassay measurements will be performed to verify the effectiveness of the respirators.

### 1. [Urine Samples](#)

Individuals using unsealed radioisotopes in millicurie amounts per experiment will be evaluated by the RSO 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. Radiation Safety will supply urine collection bottles, pick up urine samples and process the samples for the isotope(s) of interest.

### 2. [Thyroid Scans](#)<sup>3</sup>

- a. Thyroid scans will be conducted for personnel working with radioactive iodine and wearing respirators if the duration of exposure and/or the concentrations are unknown.
- b. Routine bioassay is required for individuals who, during three consecutive months, handle quantities of radioactive iodine exceeding the activities from [Table 2](#). Others individuals working within a few meters and in the same room should also participate in bioassay.
- c. Types of bioassays to be performed
  - (1) **Baseline:** Within two weeks prior to beginning work with amounts exceeding those set forth in [Table 2](#).
  - (2) **Routine:** At frequencies specified in item 4.
  - (3) **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.
  - (4) **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.

---

<sup>3</sup>See NRC Regulatory Guide 8.20

Table 2

**Activity Levels Above Which Bioassay for I<sup>125</sup> or I<sup>131</sup> is Necessary  
(from USNRC Regulatory Guide 8.20, as amended by 10 CFR 20)**

<u>Types of Operation</u>	<u>Activity in Unsealed Form</u>	
	<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, but with possible release from process and occasional exposure to contaminated box and box leakage	100 mCi	1000

d. Frequency:

- (1) Initial Routine. Thyroid scans shall be conducted 6 to 72 hours following use of I<sup>125</sup> or I<sup>131</sup>, both initially and every two weeks thereafter as long as conditions described in D.1 or D.2 exist. When work with radioactive iodine is less frequent than two weeks, a bioassay is required 6 to 72 hours after every time radioactive iodine is handled.
- (2) 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:
  - (i) The average thyroid burden for each individual assayed in the working area was less than 0.12 µCi of I<sup>125</sup>, less than 0.04 µCi of I<sup>131</sup>, and less than the corresponding proportionate amount of a mixture of these nuclides during an initial three month period.
  - (ii) The quarterly average air concentration of radioiodine (µCi/ml) in air breathed by any worker does not exceed 25% of the derived air concentration (DAC) values in Appendix B to 10CFR20. When I<sup>131</sup> and I<sup>125</sup> are both present the amounts shall be weighted proportionally.
  - (iii) The working conditions during the three-month period 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 in 4.b.(1) and 4.b.(2) will be exceeded.

### D. [Air Monitoring of Radionuclides](#)<sup>4</sup>

1. The need for air sampling for possible intake of radioactive materials will be evaluated by the RSO for areas in which unsealed radioactive materials are used in quantities that will exceed  $10^4$  times the annual limit of intake (ALI). The RSO will, as a minimum, monitor the occupational intake of radioactive material by, and assess the committed dose equivalent to:
  - 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 an annual 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.

### E. [Classification of Workplaces:](#)

The University uses the following guidelines, based on recommendations from NRC [NUREG-1556](#), (Vol.11, Appendix K) and the International Labor Office [Guidelines for the Radiation Protection of Workers in Industry \(Ionizing Radiations\) Occupational Safety and Health Series 62](#), 1989.

1. 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.
2. 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

---

<sup>4</sup> see NRC Regulatory Guide 8.25

3. 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.
  - 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.

[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 µCi	10 µCi - 10 mCi	> 10 mCi
II High	< 100 µCi	100 µCi - 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

- 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.

*Example 1. The radiotoxicity hazard for P-32 and S-35 is moderate (group III). During the weeks when stock solutions are prepared and used the modifying factor is 10. Multiplying the activity limits in Table 3 by 10 shows that the workplace is Type B if the total activity of both isotopes is between 10 mCi and 10 Ci. During weeks in which the activity falls below 10 mCi the lab is Type C. If solutions or waste are stored but no radioactivity is used, up to 100 mCi total activity can be stored.*

*Example 2. A lab purchases 5 mCi lots of I-125 sodium iodide in solution. The radiotoxicity hazard for I-125 is high (group II). Iodinations are performed (a normal chemical operation). The modifying factor during weeks when iodinations are performed is 1.0. This lab is classified as Type B whenever 100  $\mu$ Ci to 100 mCi are used. If the I-125 goes into storage and no new I-125 is purchased, the modifying factor is 100. (If less than 10 mCi is in storage the lab classification drops to Type C.)*

4. The following are general considerations for the design of all radioactive materials workplaces:
  - a. As far as is practicable, work areas of all types should be reserved exclusively for radioactive substances and isolated from other workplaces. Radioactive materials in unsealed forms should be confined in order to prevent the release of material and the spread of contamination. 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. Surfaces should be smooth and non-porous, to facilitate decontamination. Trays and/or absorbent materials should be used to catch and retain spilled liquids.
  - c. For gamma-emitting sources, shielding consisting of lead or other high-density material in the form of bricks, panels, storage containers, etc. may be used on bench tops, in fume hoods or in glove boxes to reduce radiation exposure. For high-energy beta-emitting materials, shielding of low atomic number material, such as high-density plastic, should be used to reduce the exposure.
  - 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. Waste containers should be appropriately labeled. These containers should be shielded as necessary, placed near the waste generation

areas and away from areas frequently occupied by personnel. These containers should be effectively closed to prevent release of radioactive materials.

- f. A changing area should be provided at the entrances of controlled areas in order to prevent spread of contamination to outside areas. Clean clothes should be left outside the area. Protective clothing, equipment and containers for discarded contaminated clothing should remain on the active side of the barrier.
  - g. Personal dosimetry should be stored away from radiation sources in low radiation areas levels when not in use.
  - h. Washing facilities shall be available which are appropriate to the level of radioactivity in the workplace. Faucets should be operable by foot, knee, or elbow whenever possible.
  - 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.
  - j. Use areas should be well lighted and uncluttered to avoid spills and other accidents that could result in contamination.
  - k. Before leaving a controlled area, persons shall monitor their hands, feet and clothing with equipment appropriate to the type and levels of radioactive materials present.
5. 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 combined with continuous air movement into a fume hood.
6. 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.
  - 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 lever-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.
7. 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.



### F. [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 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 the RSO 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. Exemptions to labeling requirements are allowed if the authorized user meets the criteria described in 10 CFR 20.1905, "Exemptions to labeling requirements."
5. Transporting radioactive material between rooms, buildings and/or field sites outside the confines of the University Campus:
  - a. Between campus 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.
- 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.

### G. [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 for 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 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 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 the RSO.

- (1) Type A - not less than once per working day
  - (2) Type B - not less than once per week
  - (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 RSO personnel. These inspections will include a radiation safety audit and a preliminary survey with a hand-held instrument. In addition to the above inspections, the RSO will do wipe-test surveys of these radioisotope workplaces every six months to check for removable contamination.
3. Non-Routine Procedures

Personnel should be in the habit of surveying immediately following procedures where radioactive materials are used. At the very least, surveys shall be conducted immediately after the following cases:

- a. If the procedures are one-time only
  - b. If the procedures are performed on a less frequent basis than the survey frequency specified in [Table 3](#)
  - c. If there is a significant change in the quantities of radioactive material handled, procedures or protective equipment used
  - d. If previous surveys, personnel monitoring or bioassays indicate a possible contamination problem which should be checked more closely
4. Instrumentation
- a. Except for areas using only isotopes (such as tritium) which emit low energy radiation or where photon emitting isotopes are used and radiation levels are less than 0.2 mR/hour, each workplace shall maintain appropriate operational survey instruments according to Tables 4 and 5 below.

---

**Table 4. Operational Instruments for Workplaces**

---

<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
Type A (High Hazard)	

---

**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%
NaI 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 (NaI)*	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 \*).

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 the RSO 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 area 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 0.5 to 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) P-32 (1.71 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.

### H. [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:
  - (1) Incoming shipments of radioisotopes are checked by RSO staff 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

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:

- a. Foods and beverages are not to be consumed or stored in areas where unsealed radioactive materials are stored or used. Any food or beverage containers found in radioactive workplaces by the RSO will be confiscated. Any foodstuffs will be discarded.
- b. Smoking is not permitted in workplaces where radioactive materials are used.
- c. Applying cosmetics while in radiation workplaces is prohibited.
- d. All pipetting of radioactive materials shall be done by mechanical methods, i.e. not by mouth.
- e. When fume hoods are required, they must be approved by the RSO. 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, 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.

### I. 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. The RSO 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 the RSO 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.
6. 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 Tables 6 and 7.

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

(From NRC Regulatory Guide 8.23 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.

---

7. 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.
  8. 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](#).
- J. [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 Radiation Safety web page for details.
  3. Model procedures for Radiological emergency response can be found in [Appendix E](#).
- K. [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 inaccessible.

### L. [Leak Testing of Sealed Sources](#)

Sealed sources will be leak tested by the RSO according to conditions specified in the model leak test program published in Appendix T of the Nuclear Regulatory Commission NUREG-1556, Volume 11, [Program-Specific Guidance about Licenses of Broad Scope](#).

## IV. [Operating Procedures](#)

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

1. A permit is issued to principal users for each radioisotope or radiation device used. The application form and other documents are available through the RSO. The application is reviewed by the RSO, who submits it with comments and/or recommendations at the next scheduled meeting of the Radiation Safety Committee. The applicant may be asked to attend the meeting. (All RSC meetings are open to the public.) The RSO may issue a temporary approval pending a Radiation Safety Committee meeting.
2. Permits are specific for the types and quantities of isotopes or radiation devices, as well as the types of experiments, facilities and duration of usage. Revisions in a user program require an amended or new application.
3. Applications must contain all of the information required 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 the new user applicant. Minimum requirements for principal and independent users are listed in part C of this section.
  - b. Names and qualifications 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, research, facilities maintenance, 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 for evaluating exposures or contamination.
  - g. Types and quantities of wastes expected, and proposed methods of waste packaging and disposal.
  - h. Administrative provisions for record keeping, material control, and management review to assure safe operation.
4. 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 the RSO.

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

**All acquisitions, transfers and shipments of radiation sources must be processed through UW Radiation Safety.** This also applies to no-charge and generally licensed acquisitions.

1. All orders must be approved 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 byproduct license. The RSO takes possession of all radioactive shipments, performs surveys and/or leak tests as required, checks the package 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 the RSO to ensure that all rules and regulations are satisfied. The RSO may give special approval for blanket transfers of radioactive materials within a designated group as long as the paperwork is filed with the RSO afterward.
3. Radioactive shipments off campus must also be processed through the RSO.

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

1. A RESTRICTED AREA is one in which security is used to prevent undue risk from exposure to radiation or radioactive materials (for example, high- and very high radiation areas). All entrances to restricted areas shall remain closed and locked even when 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 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.
3. 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](#)

Frequently, but at least every six months, every principal user shall physically inventory all materials in their possession. Each principal user shall document and maintain current and accurate records of these physical inventories. These records shall include information on isotope, activity and date, as well as sufficient detail to facilitate locating the materials. The RSO will inspect these records periodically.

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

NRC and OSHA require persons working with radiation-emitting materials or devices to have training and experience based on the classification of the user and work place, and on the quantities and types of radiation sources being used. The worker's proficiency should be demonstrated through documentation or testing.

#### 1. Supervised Users

- a. All authorized persons frequenting restricted or controlled areas must receive instruction and demonstrate 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.
  - (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 Radioactive Materials Safety Plan.

### 2. 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.

### 3. Principal User

A principal user must, at a minimum, have the same training and/or experience as 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 Radiation Safety Committee 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 needed

experience.

#### 4. Classification of Workplace

Section II-E of the Radioactive Materials Safety Plan 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.

##### a. 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.

##### b. 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 experience is preferred.

##### c. Type C Workplace:

In general, a Type C (low hazard) workplace is similar to a traditional chemistry lab. The general training requirements in sections E. 1, 2 and 3 apply. 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 preferred.

### 5. Students in Radioisotope Classes

No previous training or experience is necessary in laboratory classes designed 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.

### 6. Users of Sealed Radioactive Sources (other than neutron gauges, see [Appendix F](#))

Users may be permitted to work with sealed radioactive sources incorporated into laboratory instruments (e.g. electron capture gas chromatographs, static eliminators, liquid scintillation calibration sources, gamma density sensors, etc.) without direct supervision of an independent or principal user provided:

- a. The user has sufficient training (typically 4 hours or equivalent, as determined by the RSO during the source permitting process) 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 user has “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.

### 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](#). Waste is routinely picked up and stored by RSO staff until final disposal in accordance with the University’s NRC license.

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

Principal users who discontinue the use of radioactivity are required to promptly close out radioactive accounts with the RSO. All radioactivity transfer must be processed through the RSO. A workplace close-out survey for radioactive contamination will be performed by the RSO.

### 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. Approval must be obtained from the University



Animal Care Committee and all regulations associated with animal treatment and welfare shall be followed. Items that must be considered in applying for the use of radionuclides in animals are:

1. Animals are to be regarded as a source of radiation and contamination. They should be separated from other animals and their rooms or cages should be regarded as controlled areas. The presence of vermin as potential vectors of contamination should also be considered.
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. Collection of excreta and decontamination of cages are required. Excreta, bedding, body constituents and animal cadavers shall be treated as radioactive waste. See Appendix D for proper disposal.
7. Spread of contamination through the decomposition process should be prevented by deep freezing, disinfectants, sealed plastic containers, and other approved methods.
8. Besides the initial classroom training in radiation safety, animal attendants shall have job specific training from authorized principal or independent users. This training should include observation and practice in surveys, contamination control and waste disposal.
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.



### 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 the RSO.

#### 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 his jurisdiction. Copies of these items are also to be provided to the RSO 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 the RSO. Users are provided an annual summary of their exposure records as required by regulation.

#### 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 the RSO.

[Appendix A - Documents Available from the RSO, and RSC Member List](#)

# UNIVERSITY OF WYOMING

July 1, 2018

The following documents are displayed for inspection in or across from Wyoming Hall, Room 102:

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.
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 across from Wyoming Hall, Room 102 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. Current USNRC form NRC-3, "Notice to Employees."
6. University of Wyoming Radiation Safety Program documents.

Members of the Radiation Safety Committee are as follows:

<u>Name</u>	<u>Title</u>	<u>Representing</u>
Kenneth Sims (Chair)	Associate Professor	Geology & Geophysics
Jim Herrold	Radiation Safety Officer	Research & Economic Development
Diana Hulme	Associate Vice President	Research & Economic Development
Curtis Cannell	Safety Manager	Vice President of Administration
Navamoney Arulsamy	Research Scientist, Chemistry	Arts & Science College
Enette Larson Meyer	Associate Professor	Family & Consumer Sciences
Brenda Alexander	Associate Professor	Animal Science Department
Jefferson Snider	Professor, Atmospheric Science	Engineering College
Kem Krueger	Associate Dean/Professor, Pharm	Health Sciences College
Evguenia Karina	Laboratory Technician I	Molecular Biology Department

Questions pertaining to the UW Radiation Safety Program should be directed to Radiation Safety Officer Jim Herrold 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.

**Radiation Safety Compliance**

Wyoming Hall Room 102  
1000 E. University Ave.  
Laramie, Wyoming 82071  
(307) 766-2638

**Research & Economic Development**

Old Main Room 305/308  
Dept. 3355, 1000 E. University Avenue  
Laramie, WY 82071  
(307) 766-5353

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>, \*Tl<sup>200</sup>, \*Tl<sup>201</sup>, Tl<sup>202</sup>, Tl<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.

[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	100	< 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 W, sulfides, halides, and nitrates Y, oxides and hydroxides	3E+2 kidneys (4E+2) -- --	4E+1 kidneys (5E+1) 1E+2 kidneys (1E+1) 1E+1	1E-8 -- 5E-8 -- 5E-8
Cr-51 (ε,γ)	27.704 d	1,000	-----	D, all other compounds W, halides and nitrates Y, oxides and hydroxides	4E+4 -- --	5E+4 2E+4 2E+4	2E-5 1E-5 8E-6
Cu-64 (β <sup>-</sup> ,β <sup>+</sup> ,ε)	12.701 h	1,000		D, all other compounds W, halides and nitrates Y, oxides and hydroxides	1E+4 -- --	3E+4 2E+4 2E+4	1E-5 1E-5 9E-6
H-3 (β <sup>-</sup> )	12.35 y	1,000	< 0.2	Water, DAC includes skin absorption Gas (HY or T <sub>2</sub> ) submersion	8E+4 8E+4	8E+4 8E+4	2E-5 2E-5
I-125 (ε,γ,e <sup>-</sup> )	60.14 d	1	1,400 @ 1 cm	D, all compounds	4E+1 thyroid (1E+2)	6E+1 thyroid (2E+2)	3E-8 --
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 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	6E+2 --	9E+2 4E+2	4E-7 2E-7
P-33 (β <sup>-</sup> )	25.3 d	100	< 10	D, see P-32 W, see P-32	6E+3 --	8E+3 3E+3	4E-6 1E-6
S-35 (β <sup>-</sup> )	87.44 d	100	< 10	Vapor D, sulfides and sulfates except those given for W  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	--  1E+4 LLI wall (8E+3)  6E+3	1E+4  2E+4 --	6E-6  7E-6 --
Se-75 (ε,γ)	119.8 d	100		D, all other compounds W, oxides, hydroxides, carbides, and elemental Se	5E+2 --	7E+2 6E+2	3E-7 3E-7

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

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

# How do I dispose of my radioactive waste?



## Radiation Safety Compliance

Before you request a Radioactive Waste pickup you must have the materials and paperwork in order. RMMC may refuse to pick up waste if it is not properly packaged, labeled and documented. If you have any questions, please call the Regulated Materials Management Center, 766-3697.

**1. Use leak-proof, well-sealed waste containers:**

- a. Liquid waste: 20-liter carboys are available at the RMMC free of charge. If labs do not dispose of large amounts of liquids RMMC will try to work something out. Waste will not be accepted in containers that are not authorized by RMMC.
- b. Solid waste: All solids should be kept out of the liquid waste. RMMC supplies 5 gallon plastic buckets with lids for solid waste. Otherwise, lightweight waste should be double-bagged, and sharps and other bulky waste should be placed in boxes or jars.

**2. Separate hazardous waste from other waste:** An example is scintillation cocktail with toluene. Leave the liquid in the vials and place them in a separate waste container. Lead is also a hazardous waste, so lead pigs should not be combined with the other solid waste.

**3. Don't mix isotopes:** Waste with half-lives less than 120 days can be disposed as non-radioactive after decayed to background levels. All others must be packaged for off-site disposal (at a cost to your department). It is expensive to mix P-32 or I-125 waste with H-3 or C-14.

**4. Don't over-fill waste containers:** Jugs that are more than 80 percent full are difficult to transfer without spilling. Bags and other containers should not be filled to the point that they rupture or are difficult to tie. When a container is sufficiently full, a new one should be started.

**5. Label all containers with the radiation symbol and the words "Caution, Radioactive Material":** In addition, write the users name, isotope, activity (in mCi), and date on each container. Also indicate any other chemical or physical hazards (for example, "scintillation vials with toluene or "sharps").

**6. Completely fill out the Radioactive Waste Container Summary form(s):**

[http://uwyo.edu/ehs/Waste\\_Management/documents/RadWasteContainerSummaryForm.doc](http://uwyo.edu/ehs/Waste_Management/documents/RadWasteContainerSummaryForm.doc)

One form for each radionuclide must accompany the waste. Make sure to include all the information requested (see the instructions also on the web site).

**7. AFTER you have all of the above completed, NOW you should request a pickup:** Fill out the disposal request on our web site (<http://www.uwyo.edu/serverreports/HazPickUp.aspx>). If you do not have access to the internet, you can call the RMMC at 766-3697. Information on the kind of waste, how many containers and whose lab it is from should be provided. All waste and paperwork should be ready when the crew arrives. Sometimes tight schedules don't allow time for them to help fill

## [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 are also posted on the laboratory placard. If the caller dials the RSO phone number after hours, a recorded message directs the caller to the UW Police, who in turn will contact the RSO.
- 3) Alternately, if the caller is on campus and dials 911, the University Police can locate members of the RSO 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).

### 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 Radioactive Materials Safety Plan, Section III.J. report the incident to the Radiation Safety Officer (RSO) promptly (766-2638) 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 [table 8](#)).*

### 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 (766-2638) and the principal user. Telephone numbers for work and after-hours are listed on the room placard near the main lab entrance. The University Police (911) have an after-hours call list for RSO personnel.
- 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 [table 8](#)).*



### 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 (766-2638) 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 RSO personnel.
- 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 (766-2638).
- 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 [table 8](#)).*

### E) Minor Fires:

#### 1) Instructions to Workers:

- If you have received proper training and feel safe 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 (766-2638) and the principal user. Telephone numbers for work and after-hours are listed on the room placard near the main lab entrance. The University Police (911) have an after-hours call list for RSO personnel.
- 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 [table 8](#)).*

**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 (766-2638) 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 University Police (911) have an after-hours call list for RSO personnel.
- Any loss of radioactive material must be reported to the RSO (766-2638) 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 R 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 [table 8](#)).*

### 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 (766-2638) 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 RSO 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 [table 8](#)).*

## H) Notifications

**Table 8. Typical NRC Notifications and/or Reports** (NUREG-1556, Volume 11, Appendix N)

<b>Event</b>	<b>Telephone Notification</b>	<b>Written Report</b>	<b>Regulatory Requirement</b>
Theft or loss of material	immediate	30 days	10 CFR 20.2201(a)(1)(I)
Whole body dose greater than 0.25 Sv (25 rems)	immediate	30 days	10 CFR 20.2202(a)(1)(I)
Extremity dose greater than 2.5 Sv (250 rems)	immediate	30 days	10 CFR 20.2202(a)(1)(iii)
Whole body dose greater than 0.05 Sv (5 rems) in 24 hours	24 hours	30 days	10 CFR 20.2202(b)(1)(I)
Extremity dose greater than 0.5 Sv (50 rems) in 24 hours	24 hours	30 days	10 CFR 20.2202(b)(1)(iii)
Whole body dose greater than 0.05 Sv (5 rems)	none	30 days	10 CFR 20.2203(a)(2)(I)
Dose to individual member of public greater than 1 mSv (100 mrems)	none	30 days	10 CFR 20.2203(a)(2)(iv)
Defect in equipment that could create a substantial safety hazard	2 days	30 days	10 CFR 21.21(d)(3)(I)
Event that prevents immediate protective actions necessary to avoid exposure to radioactive materials that could exceed regulatory limits	immediate	30 days	10 CFR 30.50(a)
Equipment is disabled or fails to function as designed when required to prevent radiation exposure in excess of regulatory limits	24 hours	30 days	10 CFR 30.50(b)(2)
Unplanned fire or explosion that affects the integrity of any licensed material or device, container, or equipment with licensed material	24 hours	30 days	10 CFR 30.50(b)(4)

**Appendix F - NUCLEAR GAUGE & SEALED SOURCE SAFETY PLAN**

**I. General**

This Safety Plan covers the procedures for the safe and proper use and possession of radioactive materials as contained in portable moisture/density gauges and other instruments. When handled in accordance with this plan, exposures to the licensee's employees or the general public will be as low as reasonably achievable. The University has implemented, and will maintain the "Operating, Emergency, and Security Procedures" in the errata sheet of [Appendix H of NUREG-1556, Volume 1, Revision 1](#). Copies of this Plan will be provided to all gauge users and at each job site.

**II. Organization and Responsibilities**

A. Nuclear Regulatory Commission (NRC) Materials License:

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, the license specifies the following:

1. 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.
2. Licensed material shall be used by, or under the supervision of, individuals designated by the Radiation Safety Committee.
3. Sealed sources: shall not be opened by the licensee.
4. All sealed sources, for which it is required under 10 CFR 31.5, will be leak tested at least every six months.
5. In the absence of a certificate from a transferor indicating that a leak test has been performed within 6 months prior to the transfer, a sealed source shall not be put into use until tested.
6. 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."
7. The RSO shall conduct a physical inventory every 6 months to account for all sources and/or devices possessed under the license.
8. If sealed sources are in storage and not being used, they must be inventoried but need not be leak tested. The sources shall be leak

## Nuclear Gauge and Sealed Source Safety Plan

tested if taken out of storage for use or transfer to another person.

9. When not in operation and under the direct supervision of an authorized user, each sealed source shall be secured with at least two separate sets of locking devices. This includes:
  - a. A lock on the device or outer locked container designed to prevent unauthorized or accidental removal of the sealed source from its shielded position and;
  - b. The source or its container must be secured from unauthorized access when in transport or storage.

### B. Radiation Safety Committee

For a full description of the membership and duties of the Radiation Safety Committee, refer to the Radioactive Materials Safety Plan. As pertaining to nuclear gauging devices, the committee has the following duties:

1. Establish criteria for evaluating potential users and uses of ionizing radiation.
2. Develop procedures and criteria for training and testing each category of worker, and for evaluating the effectiveness of the training program.
3. Periodically review and update the Radiation Safety program, and periodically distribute information in order to ensure compliance with the program and applicable regulations.
4. The committee may delegate some of its functions to the RSO, RSO staff, or to subcommittees, but is responsible for the ultimate performance of these functions.

### C. Radiation Safety Officer (RSO)

For a full description of the qualifications and duties of the RSO, refer to the UW Radioactive Materials Safety Plan. Pertaining to sealed sources, the RSO shall have the following duties:

1. To ensure compliance with all terms and conditions of the license and that the program is up-to-date and accurate.
2. To ensure that the equipment is inventoried and leak-tested every six months, as required by the license.
3. 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.

## Nuclear Gauge and Sealed Source Safety Plan

4. To issue the proper monitoring devices and see that users wear them.
  5. To maintain records as required by the license and regulations, including:
    - a. Personnel and general public monitoring
    - b. Leak tests
    - c. Training
    - d. Inventory
  6. To ensure that all equipment is properly secured against unauthorized removal at all times.
  7. 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.
  8. To arrange proper training for authorized users.
  9. To post all required signs and notices at source storage locations.
  10. To see that receipt and shipments of all sealed sources by commercial carrier are in accordance with applicable regulations.
- 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 operation and maintenance of the device.
  2. All Authorized Users should:
    - 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. If personnel dosimetry is provided:
  - 1. Always wear your assigned dosimeter when using the portable gauge. Never wear another person's dosimeter;
  - 2. Never store your dosimeter near the portable gauge.
- B. Before removing the portable gauge from its place of storage, ensure that, where applicable, each portable gauge sealed source is in the fully shielded position and that in portable gauges with a movable rod containing a sealed source, the source rod is locked (e.g., keyed lock, padlock, mechanical control) in the shielded position. Place the portable gauge in the transport case and lock the case.
- C. Use the portable gauge according to the manufacturer's instructions and recommendations.
- D. Always maintain constant surveillance and immediate control of the portable gauge when it is not in storage. At job sites, do not walk away from the portable gauge when it is left on the ground. Take action necessary to protect the portable gauge and yourself from danger of moving heavy equipment.
- E. Do not touch the unshielded source rod with your fingers, hands, or any part of your body. Do not place hands, fingers, feet, or other body parts in the radiation field from an unshielded source.
- F. Unless absolutely necessary, do not look under the portable gauge when the source rod is being lowered into the ground. If you must look under the portable gauge to align the source rod with the hole, follow the manufacturer's procedures to minimize radiation exposure.
- G. If portable gauges are used for measurements with the unshielded source extended more than 3 feet beneath the surface, use piping, tubing, or other casing material to line the hole from the lowest depth to 12 inches above the surface. If the piping, tubing, or other casing material cannot extend 12 inches above the surface, cap the hole liner or take other steps to ensure that the hole is free of debris (and it is unlikely that debris will re-enter the cased hole) so that the unshielded source can move freely (e.g., use a dummy probe to verify that the hole is free of obstructions).
- H. After completing each measurement in which the source is unshielded, immediately return the source to the shielded position.

## Nuclear Gauge and Sealed Source Safety Plan

- I. When not being used for field measurements, portable gauges will be locked and returned to their storage/transportation case.
- J. When field operations are complete, portable gauges will be returned to their permanent storage locations as soon as possible.
- K. While the source is in the operator's possession, the operator will have:
  - 1. A copy of this [Radioactive Materials Safety Plan](#)
  - 2. A copy of the instrument operating manual
  - 3. A copy of the current leak test certificate

### IV. [Storage](#)

- A. Posting. Signs with the approved radiation symbol and the appropriate wording are posted on storage and usage areas as follows:

**CAUTION RADIOACTIVE MATERIAL:** for accessible areas in which radioactive materials are stored in combined quantities greater than or equal to ten times the activity for the radionuclide from column 3, [Appendix C](#) of the [Radioactive Materials Safety Plan](#), 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.

- B. Security
  - 1. When the portable gauge is not in use, place the portable gauge in a secured storage location with two independent physical controls. Examples of two independent physical controls are:
    - a. Securing the portable gauge in a locked storage facility located in a separate secured area in a warehouse;
    - b. Securing the portable gauge inside a locked van and secured to the vehicle with a steel cable;

## Nuclear Gauge and Sealed Source Safety Plan

- c. or storing the portable gauge inside a locked, nonremovable box and further securing the box with a steel cable or chain.
2. If chains or cables are used as a method of providing security, one of the two chains or cables used, should be substantially more robust and more difficult to cut than the other. Simply having two chains or cables with locks would not satisfy the security rule unless each chain and lock combination were physically robust enough to provide both a deterrence and a reasonable delay mechanism.
3. While transporting a portable gauge, a licensee should not modify the transportation case if it is being used as the Type A container for transporting the device. This includes, but is not limited to, drilling holes to mount the case to the vehicle or to mount brackets or other devices used for securing the case to the vehicle. In order to maintain its approval as a Type A shipping container, the modified package must be re-evaluated by any of the methods described in 49 CFR Part 178.350 or 173.461(a). The reevaluation must be documented and maintained on file in accordance with DOT regulations.

### C. Safety

1. Portable nuclear gauge devices should be stored no closer than 15 feet from the nearest workstation.
2. Always keep unauthorized persons away from the portable gauge.
3. Members of general public shall not receive an equivalent dose more than: 2 millirem in any one hour or 100 millirem per year.
4. After making changes affecting the portable gauge storage area (e.g., changing the location of portable gauges within the storage area, removing shielding, adding portable gauges, changing the occupancy of adjacent areas, moving the storage area to a new location), reevaluate compliance with public dose limits and ensure proper security of portable gauges.

### D. Temporary Storage

1. If the portable sealed source 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

## Nuclear Gauge and Sealed Source Safety Plan

For security and safety reasons, sealed radioactive sources should be put into storage at the Regulated Materials Management Center (RMMC) while not in use. This room is specifically designed and labeled for storage of radioactive materials and is kept locked at all times. 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 followed.

- A. Call the RMMC at 766-3698 as far in advance as practical to make arrangements.
- B. Bring some form of identification (and a letter from the Principal User, if necessary).
- C. Wear the film badge issued to you by the RSO. If you do not have a film badge you must first go to Wyoming Hall room 102 to be issued one first.
- D. When you arrive at the RMMC you will sign a checkout form, giving the source identification, date checked out and the estimated date of return to RMMC storage. Your signature will be compared to the signature page for that device.
- E. No source shall 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 in a vehicle.
- F. When not in use, the radioactive device shall 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.
- G. When finished with the source, you shall 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 RSO personnel.
- H. For instruments not stored at the RMMC, a check-out log shall 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

All shipping cases shall have the following labels and markings:

## Nuclear Gauge and Sealed Source Safety Plan

1. Radioactive white I or yellow II square-on-point DOT label:
    - a. Two on opposite sides, describing the radioactive material isotope, activity (in international units) and transport index (TI) if required.
    - b. Yellow II is applicable if the dose rate on the surface of the package is 0.5 to 5.0 mrem/hr (including neutron dose).
    - c. The transport index is the dose rate in mrem/hr at one meter from the surface of the package (including neutron dose).
    - d. Vehicles in which white I or yellow II labeled cases are transported do not need to be placarded.
  
  2. Package markings and description:
    - a. R.Q., RADIOACTIVE MATERIAL, SPECIAL FORM N.O.S., UN 2974
    - b. USA DOT 7A, TYPE A PACKAGE
  
  3. DANGER - CARGO ONLY label, if transported by air:
- B. Security
1. Transport the sealed source 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 shall be locked while moving.
  4. In the back of a pickup truck, the case shall be securely attached, locked, blocked and braced.
  5. When left in the vehicle, the instrument shall be locked. Ignition keys should be removed and the driver's compartment locked.
- C. The following documentation, carried at all times, shall 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

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. 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. Perform routine cleaning and maintenance according to the manufacturer's instructions and recommendations.
- B. 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.
- C. 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 the nuclear gauge 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. Emergency Procedures**

- A. If the source fails to return to the shielded position (e.g., as a result of being damaged, source becomes stuck below the surface), or if any other emergency or unusual situation arises (e.g., the portable gauge is struck by a moving vehicle, is dropped, is in a vehicle involved in an accident):
1. Immediately secure the area and keep people at least 15 feet away from the portable gauge until the situation is assessed and radiation levels are known. However, perform first aid for any injured individuals and remove them from the area only when medically safe to do so.
  2. If any heavy equipment is involved, detain the equipment and operator until it is determined there is no contamination present.
  3. From a safe distance that minimizes personal radiation exposure, visually inspect the gauge to determine the extent of the damage to the source, source housing and shielding.
  4. Portable gauge users and other potentially contaminated individuals should not leave the scene until emergency assistance arrives.
  5. At the earliest opportunity after the situation is under control, contact the RSO at 766-2638. After hours, contact the University Police at 766-5179. Never leave the instrument unattended. Describe the situation and follow the instructions of the RSO.
- B. RSO and License Management
1. Arrange for a radiation survey to be conducted as soon as possible by a knowledgeable person using appropriate radiation detection instrumentation. This person could be a licensee employee using a survey meter located at the job site or a consultant. To accurately assess the radiation danger or potential contamination, it is essential that the person performing the survey be competent in the use of the survey meter.
  2. If portable gauges are used for measurements with the unshielded source extended more than 3 feet below the surface, contact persons listed on the emergency procedures need to know the steps to be followed to retrieve a stuck source and to convey those steps to the staff on site.
  3. Make necessary and timely notifications to local authorities as well as to NRC as required. (Even if it is not required, you may report any incident to NRC by calling NRC's Emergency Operations Center at (301) 816-5100, which is staffed 24 hours a day and accepts collect calls.) NRC notification is required when portable gauges containing

## Nuclear Gauge and Sealed Source Safety Plan

licensed material are lost or stolen, when portable gauges are damaged or involved in incidents that result in doses in excess of 10 CFR Part 20.2203 limits, and when it becomes apparent that attempts to recover a sealed source stuck below the surface will be unsuccessful.

4. Reports to NRC must be made within the reporting time frames specified by the regulations (see table 8).

C. The RSO shall notify the NRC according to Table 8 below.

**Table 8. Typical NRC Notifications and/or Reports** (NUREG-1556, Volume 11, Appendix N)

Event	Telephone Notification	Written Report	Regulatory Requirement
Theft or loss of material	immediate	30 days	10 CFR 20.2201(a)(1)(I)
Whole body dose greater than 0.25 Sv (25 rems)	immediate	30 days	10 CFR 20.2202(a)(1)(I)
Extremity dose greater than 2.5 Sv (250 rems)	immediate	30 days	10 CFR 20.2202(a)(1)(iii)
Whole body dose greater than 0.05 Sv (5 rems) in 24 hours	24 hours	30 days	10 CFR 20.2202(b)(1)(I)
Extremity dose greater than 0.5 Sv (50 rems) in 24 hours	24 hours	30 days	10 CFR 20.2202(b)(1)(iii)
Whole body dose greater than 0.05 Sv (5 rems)	none	30 days	10 CFR 20.2203(a)(2)(I)
Dose to individual member of public greater than 1 mSv (100 mrems)	none	30 days	10 CFR 20.2203(a)(2)(iv)
Defect in equipment that could create a substantial safety hazard	2 days	30 days	10 CFR 21.21(d)(3)(I)
Event that prevents immediate protective actions necessary to avoid exposure to radioactive materials that could exceed regulatory limits	immediate	30 days	10 CFR 30.50(a)
Equipment is disabled or fails to function as designed when required to prevent radiation exposure in excess of regulatory limits	24 hours	30 days	10 CFR 30.50(b)(2)
Unplanned fire or explosion that affects the integrity of any licensed material or device, container, or equipment with licensed material	24 hours	30 days	10 CFR 30.50(b)(4)