Radiation Safety Manual

University of Montana

October 2019

RSC 10-19A

Regulations Concerning the Procurement and Use of Sources of Radiation

University of Montana

I. Scope

These regulations pertain to all artificially produced radioactive isotopes which must be licensed pursuant to the regulations in Title 10, Chapter 1, Parts 19, 20, 30 and 33 of the Federal Register and to any radiation-producing device or source which is capable of providing radiation in excess of the standards listed in Title 10, Chapter 1, Part 20 of the Federal Register.

II. Procurement of Radioactive Materials

A. Applicant must file the following information with the Radiological Safety Officer. Use the online form found at: http://www.umt.edu/research/eh/raduserappilcation.doc

1. Resume of experiment(s) in which radioactive material(s) is (are) to be used. This must include specific isotope(s) and amount(s) to be used. A list of all persons connected with the project who will control the use of radioactive materials must also be included. This list of personnel must be updated as changes in personnel occur.

2. Equipment and facilities available pertinent to the measurement and safe use of radioactive isotopes. This must include descriptions of counting and survey instruments, as well as hoods, shielding, waste disposal equipment, etc.

3. A brief account of specific measures the applicant will take to ensure adherence to radiological safety standards. The applicant should be guided here by a thorough knowledge of the information contained in CFR Title 10, Chapter 1, Parts 19 and 20 and other safety-related documents provided in this handbook.

4. A brief account of the experience of the applicant and other individuals involved in the use of radioactive isotopes. This must include isotope(s) used, the amounts used, and when and where experience was gained. (Note: Part 4 will be required only when the first application is made unless project personnel changes.)

B. Committee Action -- Upon receipt of the completed Authorized User Application, the Radiological Safety Officer or a designated member of the Committee will present the information to the Radiation Safety Committee. The applicant may be required to appear in person before the Committee the first time application is made.

C. Procurement -- When the Committee has approved the application, the applicant becomes an Authorized User of radioactive materials at this institution. Purchase of materials may then be accomplished only by submitting a radiation order form to the RSO or RSOS. The order form can be found at: http://www.umt.edu/research/eh/Radorder%20formhtml.htm It will be the duty of the RSO or RSOS to make certain, before placing any order, that the material being ordered will not cause the total campus inventory of that nuclide to exceed the possession limit stated in the NRC license. All radioactive shipments are sent to the Physical Plant. Personnel there will call your lab within 1 hour of receipt of the package. The package shall be monitored as soon as practical after receipt of the package in your lab, but not later than 3 hours after the package is received at the Physical Plant. If a shipment is expected during off-duty hours (e.g., by air express) the authorized user must make all specific arrangements necessary for its safe receipt. If he/she does not, the material will remain in custody of the carrier until the next opportunity for delivery during office hours.

III. Unlicensed materials

Not applicable at this time.

IV. Safety

A. Storage and Use -- The storage and use of radiation sources shall be such that the exposure shall not exceed standards of permissible radiation exposure as stated in Title 10, Section 1201, Part 20 of the Federal Register.

B. Inspections -- Inspections will be made by the Radiological Safety Officer or a designated member of the Radiation Safety Committee of those laboratories and project areas using or possessing radiation. These inspections are to be done as often as safety dictates, but at least once every quarter. Permanent records of these surveys shall be kept by the Radiological Safety Officer or a designated member of the Committee.

C. Instrumentation -- All individuals or departments using radiation sources must have available appropriate survey meters. Hand-survey meters will be checked for operability by the RSOS during each quarterly inspection.

D. Contamination Control states -- Each authorized user who makes more or less continuous use of byproduct material or who has stock on hand even if not used must make a systematic survey for contamination of equipment and work area surfaces at least once per month. Surveys are required immediately following each experiment or material-handling session, e.g., receipt of new radioactive material. Written records of these surveys and their results must be preserved for inspection by the RSO or the designated member of the RSC. The records must be kept on file for inspection in the lab.

Survey methods for each radionuclide in use at the University of Montana may be found in the reference section of the Radiation Safety Manual pages 4-1 through 4-

10. These methods will provide guidance on post-use surveys. For the monthly survey, wipe tests must always be done and instrument surveys also done where appropriate. The RSO may do instrument surveys if appropriate, as part of each quarterly inspection and spot check the area via wipe tests on a random basis.

Contamination at any location in excess of three times normal background requires decontamination of the work area or surface. If you feel you are unable to proceed with the decontamination, call the RSO at 243-4503 or 544-1636 for further information.

E. Waste Disposal -- It is Radiation Safety Committee policy that intentional disposal of radioactive material in any significant amount into the sanitary sewer system is forbidden within individual labs. This includes primary decontamination rinses from contaminated equipment such as glassware. All wastes should be pooled and disposed of according to procedures outlined in Guideline RSC 10-19E.

F. Radiation Warning Signs and Placards -- All laboratories where radiation sources are stored or used shall be posted as prescribed in Title 10, Section 1902, Part 20 of the Code of Federal Regulations. This means a warning sign bearing the radiation symbol and the words "CAUTION, RADIOACTIVE MATERIAL(S)" or "DANGER, RADIOACTIVE MATERIAL(S)" as appropriate on the door of each room containing radioactive material. Each main work area must be identified and posted. A current copy of form NRC-3, and notification of the places (or persons) where employees or students may have access to full copies of the regulations must be included in each area controlled by an authorized user.

G. Radionuclides must be controlled at all times. This means that radioactive materials must be secured when not in use. In use, radioactive materials must be under the direct supervision and control at all times of an individual who has met the minimum training requirements of the University of Montana.

RSC 10-19B

General Laboratory Rules for the Use of Radioactive Materials

University of Montana

I. The individual in charge of each laboratory must be familiar with and observe the provisions of the "Regulations Concerning the Procurement and Use of Sources of Radiation" (RSC 9-89-A) for the University of Montana. The NRC requires that all radioactive materials be in secure (locked) storage or under the direct and constant supervision of the user.

II. The following general rules will apply in all laboratories and to all personnel using laboratories where radioactive materials are used or stored.

A. Eating, drinking, utensil storage or food and beverage storage or using of cosmetics will be allowed in designated areas only. No, radioactive, biological or laboratory chemical materials may be present at any time in designated areas. All designated areas must be clearly signed and marked with blue tape. All designated areas must be included in the laboratory contamination survey program

B. Absolutely no oral pipetting or similar operation will be allowed. Use a syringe or other type pipet control.

C. No radioactive materials may be discharged in any lab sink unless specifically approved in the Authorized User Application, or by usual waste disposal services. All ordinary wastes generated in a controlled laboratory which might conceivably be contaminated must be surveyed with an appropriate survey instrument before being deposited in non-controlled wastebaskets.

D. Any wounds or spills of a quantity greater than that indicated in Appendix C of Title 10, Chapter 1, Part 20, Code of Federal Regulations, or one where contamination cannot be completely removed; shall be reported immediately to the Radiation Safety Officer or to the Radiation Safety Committee, who will then notify the NRC.

E. Any incident (fire, explosion, spill, etc.) which involves radioactive material and which results in contamination of work areas outside of such control areas as hoods, shielded storage, etc., shall be reported to the RSO or the Radiation Safety Committee immediately if there is any possibility of uncontrolled contamination. The purpose of this regulation is to allow investigation and consultation with the intent of improving procedures, techniques or equipment to achieve greater safety.

F. An adequate survey of hands and clothing must be made before removing protective clothing and before leaving the radioactivity control area (laboratory or portion thereof). If any activity is found, it must be reported to the person in charge of the laboratory and decontamination accomplished before leaving the area.

G. Proper and careful housekeeping practices must be observed. To this end, proper equipment should be provided (e.g., raised edge trays, waterproof backed absorbent paper to cover work areas, dry waste containers, jars for liquid waste, masking tape, etc.).

III. The person in charge of each teaching laboratory or research project shall compile an appropriate set of "Laboratory Rules and Procedures" for its use of radioactive materials. These must be approved by the Radiation Safety Committee and be reasonably available in the laboratory. They shall be filed in or with the Radiation Safety Manual. They shall include Section IV of "Regulations Concerning the Procurement and Use of Sources of Radiation" for the University of Montana, and the eight general rules given under II above. In addition, specific, clear and detailed procedures shall be provided for the material and equipment in use on the project. Documentation of this training for all new hires is required prior to their working with radioactive materials. This training shall be provided by the authorized user or designee. The following points at a minimum should be covered by these additional rules and procedures:

A. The transportation of samples from one work location to another must be done using equipment and techniques that will minimize the possibility of contamination whether by spill, dusting, or any other means.

B. Definite procedures must be prescribed <u>in advance</u> which will contain and safely clean up any spilled material. The size, identity and the chemical and physical state of samples in use should be taken into consideration.

C. Clear procedures must be outlined for handling and marking glassware and other containers, and for washing and/or decontaminating them.

D. Rules must be established governing the use of protective clothing and equipment such as coveralls, lab coats, rubber gloves, etc., specifying when and where they must be used and how they should be stored when not in use.

E. Techniques should be prescribed for mounting samples for counting that will prevent the spread of contamination.

F. When the nature and quantities of the nuclides in use make whole-body dose rates to be anything but obviously negligible, the authorized user is obligated to provide adequate and effective equipment and procedures for monitoring the doses accumulated by himself/herself and all others associated with the project or course of study. This is intended to mean that for the use in tracer quantities of such nuclides as ^{3}H and ^{14}C, film badges and/or dosimeter pencils are useless and therefore not required. For nuclides such as ^{32}P, ^{51}Cr and ^{125}I (or others of similar penetrating power) it is the option of the project director to provide and require the regular use of thermoluminesent dosimeters if there is any possibility of an individual exceeding one tenth of the allowable annual dose. This potential will be reviewed by the Radiation Safety Committee as part of the normal review process. Federal regulations require that permanent records be kept showing these data, and any employee has the right to ask for copies at any time during or after his or her tenure at this institution. It is the

duty of the RSO to maintain and administer these records and advise each worker annually, in writing, of the worker's dose as shown in these records.

G. Shielding materials and/or devices will be provided for use when hard-beta (e.g., ^{32}P) or gamma emitters are handled. The size and shape of these objects will depend on the nature of the work location, but they shall be such as to provide a sufficient thickness. Examples are 1/8 to 1/4-inch lucite (beta), and appropriate thickness of lead sheet or blocks (gamma).

H. Where students are being instructed in the use of radioactive isotopes, the following additional points will be included.

1. The degree of supervision provided each student in a class using radioactive isotopes in experiments will be decided on by the Radiation Safety Committee on the basis of the hazards inherent in the particular experiment(s). Normally, the number of students per staff member will not exceed ten. They will be supervised by instructors and assistants. At least one instructor will be in the laboratory at all times when students are present.
2. The quantity of radioactivity to be used for each experiment and the amount of radioactivity to be handled by each student.
3. A copy of the radiological health-safety instructions which will be given to each student.

IV. Minors may work in labs using radioactive materials under the following conditions:

1. Under no circumstances should unsponsored minors be allowed to use radioactivity. Sponsored means recommended by a high school program or through ACS or other means.
2. Each minor (individual under 18) shall have a parental consent form on file with the authorized user. The consent form will stipulate that the parent(s) understand that the minor will be using radioactive materials in a research environment.
3. Each minor will be trained on the individual standard operating procedures for the lab and this training will be documented in writing and filed with other employee training documentation.
4. The minor will take the same two hour training required of regular employees.
5. The level of radioactivity used by minors will be kept at the absolute minimum while conducting the experiment. The policy of exposure as low as reasonably achievable will be strictly enforced. Minors and declared pregnant women may receive only 10% of the normally allowed occupational dosage.

RSC 10-19C

Exposure Guidelines

The maximum exposure of an individual to radiation must not be such as to exceed the limits indicated in paragraph 20.1201, Title 10, Chapter I, Part 20, Code of Federal Regulations. It is the responsibility of the licensee to conduct operations so that the effective dose to members of the public does not exceed the limits indicated in paragraph 20.1301, Title 10, Chapter I, Part 20, Code of Federal Regulations.

The maximum exposure of a declared pregnant woman, as defined in paragraph 20.1003, Title 10, Section I, Part 20, CFR, as a woman who has voluntarily informed her employer, in writing, of her pregnancy and estimated date of conception, must not exceed the limits indicated in paragraph 20.1208, Title 10, Chapter I, Part 20, Code of Federal Regulations.

Contamination Surveys

Facilities and Equipment

- To ensure achieving the required sensitivity of measurements, survey samples will be analyzed in a low-background area.
- A gamma counter system with a single or multi-channel analyzer can be used to count samples containing gamma-emitters (e.g., cesium-137, cobalt-60).
- A liquid scintillation or gas-flow proportional counting system can be used to count samples containing alpha-emitters, beta-emitters, and gamma-emitters (if efficiency is great enough to achieve the required sensitivity for measurements).

Ambient Radiation Level Surveys

- Dose-rate surveys, at a minimum, should be performed in locations where workers are exposed to radiation levels that might result in radiation doses in excess of 10% of the occupational dose limits or where an individual is working in a dose rate of 0.025 mSv (2.5 mrem/hr) or more (50 mSv/year divided by 2,000 hr/year).
- 10 CFR 20.1301 requires that the total effective dose equivalent to an individual member of the public from the licensed operation does not exceed 1 mSv (0.1 rem) in a year and the dose in any unrestricted area from external sources does not exceed 0.02 mSv (2 mrem) in any one hour.

Licensees' contamination surveys should be sufficient to identify areas of contamination that might result in doses to workers or to the public. Combined removable and fixed contamination should be surveyed using appropriate radiation detection equipment. Removable contamination can be detected and measured through a wipe test of the surface, which is counted in an appropriate counting instrument, such as a liquid scintillation counter, a sodium iodide or germanium gamma counter, or a proportional alpha/beta counter.

Contamination surveys should be performed:

- To evaluate radioactive contamination that could be present on surfaces of floors, walls, laboratory furniture, and equipment
- After any spill or contamination event
- When procedures or processes have changed
- To evaluate contamination of users and the immediate work area, at the end of the day, when licensed material is used
- In unrestricted areas at frequencies consistent with the types and quantities of materials in use but not less frequently than quarterly
- In areas adjacent to restricted areas and in all areas through which licensed materials are transferred and temporarily stored before shipment.

Contamination Survey Frequency

Personnel should survey for contamination in locations where individuals are working with an unsealed form of radioactive material in an amount greater than or equal to 10% of the smallest annual limit on intake (ALI) (either the inhalation or ingestion ALI) listed for that Radionuclides in 10 CFR Part 20. These surveys should be done at a frequency appropriate to the types and quantities of radioactive materials in use, but at a minimum monthly. Table S.1 contains suggested contamination survey frequency from Regulatory Guide 8.23 (See Tables S.2, S.3, and S.4 for alternate survey frequencies).

Table S.1 Suggested Frequency of Contamination Surveys from Regulatory Guide 8.23

Areas Where RAM Has Been Used	Frequency
Areas where > 7.4 MBq (200 Ci) is used at any one time	Weekly
Areas where < 7.4 MBq (200 Ci) is used at any one time	Monthly

Alternate Survey Frequency

Classification of Laboratories

Table S.2 Survey Frequency Category

Group	Low	Medium	High
1	< 370 kBq (10 Ci)	370 kBq (10 Ci) to 37 MBq (1 mCi)	> 37 MBq (1 mCi)
2	< 37 MBq (1 mCi)	37 MBq (1 mCi) to 3.7 GBq (100 mCi)	> 3.7 GBq (100 mCi)
3	< 3.7 GBq (100 mCi)	3.7 GBq (100 mCi) to 370 GBq (10 Ci)	> 370 GBq (10 Ci)
4	< 370 GBq (10 Ci)	370 GBq (10 Ci) to 37 TBq (1000 Ci)	> 37 TBq (1000 Ci)

Proportional fractions are to be used for more than one isotope.

Table S.3 Survey Frequency Category Modifiers

Modifying Factors	Factors
Simple storage	x 100
Very simple wet operations (e.g., preparation of aliquots of stock solutions)	x 10
Normal chemical operations (e.g., analysis, simple chemical preparations)	x 1
Complex wet operations (e.g., multiple operations, or operations with complex glass apparatus)	x 0.1
Simple dry operations (e.g., manipulation of powders) and work with volatile radioactive compounds	x 0.1
Exposure of non-occupational persons	x 0.1
Dry and dusty operations (e.g., grinding)	x 0.01

The object is to determine how often to survey the laboratory. To do this, multiply the activity range under LOW, MEDIUM, and HIGH survey frequency by the appropriate Modifying Factor to construct a new set of mCi ranges for LOW, MEDIUM, and HIGH survey frequency.

Survey Frequency:

- Low - Not less than once a month
- Medium - Not less than once per week
- High - Not less than once per normal working day.

Table S.4 Isotope Groups

Group 1	Pb-210 Po-210 Ra-223 Ra-226 Ra-228 Ac-227 Th-227 Th-228 Th-230 Pa-231 U-230 U-232 U-233 U-234 Np-237 Pu-238Pu-239 Pu-240 Pu-241 Pu-242 Am-241 Am-243 Cm-242 Cm-243 Cm-244 Cm-245 Cm-246 Cf-249 Cf-250 Cf-252
Group 2	Na-22 Cl-36 Ca-45 Sc-46 Mn-54 Co-56 Co-60 Sr-89 Sr-90 Y-91 Zr-95 Ru-106 Ag-110m Cd-115m In-114m Sb-124 Sb-125 Te-127m Te-129m I-124 I-125 I-126 I-131 I-133 Cs-134 Cs-137 Ba-140 Ce-144 Eu-152 Eu-154 Tb-160 Tm-170 Hf-181 Ta-182 Ir-192 Tl-204 Bi-207 Bi-210 At-211 Pb-212 Ra-224 Ac-228 Pa-230 Th-234 U-236 Bk-249
Group 3	Be-7 C-14 F-18 Na-24 C1-38 Si-31 P-32 P-33 S-35 Ar-41 K-42 K-43 Ca-47 Sc-47 Sc-48 V-48 Cr-51 Mn-52 Mn-56 Fe-52 Fe-55 Fe-59

	Co-57 Co-58 Ni-63 Ni-65 Cu-64 Zn-65 Zn-69m Ga-72 As-73 As-74 As-76 As-77 Se-75 Br-82 Kr-85m Kr-87 Rb-86 Sr-85 Sr-91 Y-90 Y-92 Y-93 Zr-97 Nb-93m Nb-95 Mo-99 Tc-96 Tc-97m Tc-97 Tc-99 Ru-97 Ru-103 Ru-105 Rh-105 Pd-103 Pd-109 Ag-105 Ag-111 Cd-109 Cd-115 In-115m Sn-113 Sn-125 Sb-122 Te-125m Te-127 Te-129 Te-131m Te-132 I-130 I-132 I-134 I-135 Xe-135 Cs-131 Cs-136 Ba-131 La-140 Ce-141 Ce-143 Pr-142 Pr-143 Nd-147 Nd-149 Pm-147 Pm-149 Sm-151 Sm-153 Eu-152 Eu-155 Gd-153 Gd-159 Dy-165 Dy-166 Ho-166 Er-169 Er-171 (9.2 hr) Tm-171, Yb-175 Lu-177 W-181 W-185 W-187 Re-183 Re-186 Re-188 Os-185 Os-191 Os-193 Ir-190 Ir-194 Pt-l91 Pt-193 Pt-197 Au-196 Au-198 Au-l99 Hg-197 Hg-197m Hg-203 Tl-200 Tl-201 Tl-202 Pb-203 Bi-206 Bi-212 Rn-220 Rn-222 Th-231 Pa-233 Np-239
Group 4	H-3 O-15 Ar-37 Co-58m Ni-59 Zn-69 Ge-71 Kr-85 Sr-85m Rb-87 Y-9lm Zr-93 Nb-97 Tc-96m Tc-99m Rh-103m In-113m I-129 Xe-131m Xe-133 Cs-134m Cs-135 Sm-147 Re-187 Os-191m Pt-193m Pt-197m Th-232 Th-Nat U-235 U-238 U-Nat

Contamination in Unrestricted Areas

Contamination found in unrestricted areas should be immediately decontaminated to background levels. When it is not possible to get to background levels, the licensee must ensure that the amounts do not exceed the contamination levels listed in Table S.5.

Table S.5 Acceptable Surface Contamination Levels

Nuclide[1]	Average[2, 3]	Maximum[2, 4]	Removable[2, 5]
I-125, I-129	1.7 Bq/100 cm^2 (100 dpm/100 cm^2)	5.0 Bq/100 cm^2 (300 dpm/100 cm^2)	0.3 Bq/100 cm^2 (20 dpm/100 cm^2)
I-126, I-131, I-133, Sr-90	16.7 Bq/100 cm^2 (1,000 dpm/100 cm^2)	50.0 Bq/100 cm^2 (3,000 dpm/100 $cm^{2)}$	3.3 Bq/100 cm^2 (200 dpm/100 cm^2)
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.	83.3 Bq/100 cm^2 (5,000 dpm/100 cm^2)	250 Bq/100 cm^2 (15,000 dpm /100 cm^2)	16.7 Bq/100 cm^2 (1,000 dpm/100 cm^2)

[1] Where surface contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha- and beta-gamma-emitting nuclides should apply independently.

[2] 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.

[3] 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.

[4] The maximum contamination level applies to an area of not more than 100 cm^2.

[5] The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with filter or soft absorbent paper, 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.

When equipment or facilities that are potentially contaminated are to be released for unrestricted use, the above table provides the maximum acceptable residual levels. To the extent practicable, it is appropriate to decontaminate to below these levels. Surface contamination surveys should be conducted for both removable and fixed contamination before these facilities or equipment are released from restricted to unrestricted use, to ensure that they meet these limits.

A standardized method for smear testing of a relatively uniform area should be used to aid in comparing contamination at different times and places. A smear taken from an area of about 100 cm^2 is acceptable to indicate levels of removable contamination.

Survey Record Requirements

Each survey record should include the following:

- A diagram of the area surveyed
- A list of items and equipment surveyed
- Specific locations on the survey diagram where wipe test was taken
- Contamination levels with appropriate units
- Background levels
- Name of the person making the evaluation and recording the results and date.

Licensees should record contamination levels observed and procedures followed for incidents involving contamination of individuals. The record should include names of individuals involved, description of work activities, calculated dose, probable causes (including root causes), steps taken to reduce future incidents of contamination, times and dates, and the surveyor's signature.

Air Monitoring in the Workplace

Air monitoring can be used to do the following:

- Determine whether the confinement of radioactive materials is effective
- Measure airborne radioactive material concentrations in the workplace
- Estimate worker intakes of radioactive material
- Determine posting requirements
- Determine what protective equipment and measures are appropriate
- Warn of significantly elevated levels of airborne radioactive materials.

If bioassay measurements are used to determine worker doses of record, air sampling may be used to determine time of intake and to determine which workers should have bioassay measurements. The use of engineering controls and a good air sampling program can eliminate the need for bioassays.

Refer to Regulatory Guide 8.25, Revision 1, "Air Sampling in the Workplace," dated June 1992, and NUREG-1400, "Air Sampling in the Workplace," dated September 1993, for further guidance on the air sampling.

Sealed Source Devices

Frequency for Conducting Leak Tests of Sealed Sources

Leak tests will be conducted at the frequency specified in the respective SSD Registration Certificate. In the absence of a registration certificate, sealed sources shall be tested for leakage and/or contamination at intervals not to exceed 6 months.

Procedure for Performing Leak Testing and Analysis

For each source to be tested, list identifying information such as manufacturer, model number, serial number, radionuclide, and activity.

- If available, use a survey meter to monitor exposure.
- Prepare a separate wipe sample (e.g., cotton swab or filter paper) for each source.
- Number each wipe to correlate with identifying information for each source.
- Wipe the most accessible area (but not directly from the surface of a source) where contamination would accumulate if the sealed source were leaking.
- We are using an independent laboratory to conduct any sealed source leak tests. The laboratory's instrumentation is sensitive enough to detect 185 becquerels (0.005 microcurie) of the radionuclide. The laboratory ensures that it's calibration is current.
- Retain records for 3 years (10 CFR 20.2103(a)).
- If the wipe test activity is 185 Bq (0.005 mCi) or greater, notify the NRC, and immediately remove from service so that the source can be decontaminated, repaired or disposed in accord with NRC regulations.

Procedure for Check Out of Sealed Source

The individual in charge of the laboratory must submit a written request (email acceptable) to the RSO for the use and delivery of any sealed source. The RSO will require a written signature from the individual in charge of each laboratory in the RSO's logbook. The RSO's logbook contains the following information for each sealed source: Date & time delivered, location, name of individual in charge of lab, specific materials delivered, date materials were tested and inventoried, date materials retrieved by RSO.

When the sealed source is not being used for demonstration it will be in secure storage in Chemistry Stores.

Procedures for Periodic Inventorying of Sealed Source

The RSO will conduct a physical inventory every 6 months to account for all sealed sources and/or devices received or possessed under the NRB license. The date of inventory shall be entered into the RSO's logbook for each sealed source. Records of inventories shall be maintained for three years from the date of each inventory, and shall include radionuclides, quantities, and manufacturer's name and model number.

RSC 10-19D

Radiation Control Guidelines

Precautions To Be Taken in Receiving Incoming Shipments of Radioactive Materials

Radioactive materials shipments are delivered to Campus Stores. Individuals will be notified immediately upon package delivery and shall make arrangements to collect the package as soon as possible after phone notification. All incoming packages of radioactive material MUST be checked for contamination within 3 hours of receipt on campus.

Experience has shown that commercial suppliers of radioactive materials and common carrier systems both can and do make mistakes. For the safety of yourself, your employees and your students, **MAKE SURE YOUR SHIPMENT IS IN ORDER** by utilizing the following procedures:

1. Look for damage or leakage on the outer container. THE OUTER CONTAINER MUST BE WIPE TESTED FOR REMOVABLE CONTAMINATION. This monitoring must be performed utilizing a liquid scintillation counter (LSC), as soon as practicable after receipt of the package but in no event may the time from receipt to survey exceed three hours. A blank sample must be run with the actual wipe samples to document the function of the LSC.

2. Use the appropriate radiation detection instrument(s) to confirm that the TYPE and AMOUNT of radiation perceptible through the package is proper. Rarely, an incorrect amount or type of radiation will be shipped.

3. As each increment of packaging is opened and removed, check its surface for contamination, being aware that it may have been introduced by the supplier during packaging, or by non-obvious leakage during transit.

4. **RECORD THE RESULTS OF THIS INSPECTION IN YOUR PERMANENT RECORDS.**

5. Notify the RSO of mispackaging of proper isotopes or anytime the removable contamination exceeds 3 times background. If removable radioactive surface contamination exceeds the limits of 10 CFR part 71-87(i), or 71.47., the final delivery carrier and the Administrator of the appropriate NRC Regional Office listed in Appendix D to 20.1001-20.2401 must also be notified.

The text of the applicable regulations are as follows: each package of radioactive materials offered for transportation must be designed and prepared for shipment so that under conditions normally incident to transportation the radiation level does not exceed 2 mSv/h (200 mrem/h) at any point on the external surface of the package, and the transport index does not exceed 10. 10CFR 71,87 (i) refers to DOT regulation 49 CFR 173.443 that limits removable contamination to 2200 DPM per 100 square centimeters.

Radiation Control Guidelines

The Management of Classes in Which Radioactive Materials Are Used by Students

I. The individual in charge of each instructional or research activity in which students handle or use radioactive byproduct materials must make certain that they understand the following general ideas:

1. The potentially harmful effects of radiation on the human body.

2. The penetrating power of common radioactive emissions.

3. The concepts of radioactive decay half-life and biological half-life.

II. In addition, the individual in charge must make the students clearly aware of the Laboratory Rules for the Use of Radioactive Materials, as compiled by the Radiation Safety Committee (RSC4-93-B, III). The reasons and underlying principles of the rules must be explained, and appropriate techniques must be explained and demonstrated to allow compliance with the rules.

III. The program of instruction in the hazards and correct use of byproduct materials must consist of an active presentation of the ideas listed above by or under the supervision of the course instructor or research director and a formal or informal evaluation of the students' understanding of these ideas should be made before use of radioisotopes begins. Merely posting lists of University or individual laboratory rules will not be considered sufficient or in compliance with campus policies.

Radiation Control Guidelines

DISPOSAL OF RADIOACTIVE WASTES

(Refer also to Regulations Concerning the Procurement
and Use of Sources of Radiation, RSC 10-19A, IV, E)

LABELING All containers must be labeled with the name of the Authorized User, radionuclide, tape or other label indicating that the container is radioactive and the activity. (Example: Smith--^{14}C--106 uCi.--Caution Radioactive)

SEGREGATION OF RADIONUCLIDES ^{14}C and ^{3}H may be disposed of together. All other nuclides including ^{35}S, ^{32}P and, ^{125}I, must be held in SEPARATE CONTAINERS. Radioactive labels must be removed from ^{125}I and ^{32}P and S35 containers placed in dry waste. The dry waste container must be labeled as above.

DRY WASTE NO FREE LIQUIDS may be placed in the dry waste. Slightly damp gloves or counter wipes may be placed in dry waste. If it drips, there is too much liquid. ALL SHARPS AND BROKEN GLASS must be in a puncture proof container before going in the dry waste. The tops of bags must be taped or tied shut.

LIQUID WASTE AQUEOUS LIQUIDS must be placed in bulk liquid waste containers provided by Environmental Health. Only aqueous liquids my be placed in these bulk containers. If you have a liquid waste other than aqueous, call before you containerize.

SCINTILLATION FLUIDS Scintillation vials must be TIGHTLY CAPPED and placed in buckets for pickup. .

CONTAMINATED OIL Must be stabilized prior to disposal. Keep it SEPARATE from non-radioactive waste oil. The RSO will do the stabilization.

CONTAINERS must be STURDY AND EASILY MOVEABLE and NO LARGER THAN FIVE GALLONS IN SIZE FOR LIQUIDS AND DRY WASTE.

If you have questions about waste disposal, contact Kay Altenhofen at 243-4503.

radwst.dsp

RSC 10-19F

Radiation Safety Orientation Course

The Radiation Safety Orientation Course is required for all Authorized Users and their employees who use or work in the vicinity of radioisotopes. A new User or worker must take the course within 90 days of hire. The first hour of the class must be taken as a refresher course every two years. Records of attendance are taken and kept on file for review by the NRC.

The two hour course consists of a video component and a lecture component each about one hour long.

The video component will vary over time but will generally follow the content of the Indiana University series on Radiation Safety.

The lecture component relates the general information given in the videos to the specific circumstances at the University of Montana, i.e., who the RSO is, how to reach him/her, etc. as well as specific information on radioisotope theory and program changes.

In addition, specific information is given concerning:

1. Who may work with radioactive material.
2. Procurement of radioactive material.
3. Instructions for receiving radioactive shipments.
4. Lab Safety Rules and ALARA
5. Intra-laboratory transfers.
6. Radioactive waste disposal.
7. Reducing radioactive waste volume.
8. Personnel monitoring procedures.
9. Area monitoring procedures.
    a. survey meter techniques
    b. dry wipe techniques.
10. Prenatal radiation and risks.
11. Emergency procedures.
12. International Unit names and definitions.
13. Requirements, definitions from the new Part 20.

RSC 10-19G

Emergency Response Procedures

University of Montana

Except for minor spills or releases of radioactivity that can be controlled and cleaned by the user,

CONTACT:

Kay Altenhofen, Radiation Safety Officer
Phone – **4503**
Office - Building 32, Rm 138
Cell phone - **544-1636**

Keith Parker, Chairman
Radiation Safety Comm.
Phone -**4235**
Office – Skaggs 243
Home phone - **549-7030**

University Emergency number - **4000**

Emergency Responses Summary:

1. If spill or contamination involves injury administer first aid.
2. If spill is on the skin, flush thoroughly, on clothing discard.
3. If accident involves gases notify persons to vacate area; shut off hoods and fans if possible, seal area, and post warning.
4. Take immediate steps to decontaminate personnel involved.
5. Monitor all persons involved in the spill and cleanup.
6. Contact the Radiation Safety Officer or Safety Committee Chairman
7. Permit no person to resume work in the area until a survey has been made and approval of the Radiation Safety Officer is secured
8. Prepare the Spill Investigation form of the accident for the RSO.

See Emergency Response section for detailed information

STUDENT HEALTH SERVICE phone **2122**.
See RSC 10-19B, General Laboratory Rules for the Use of Radioactive Materials for further information.

Safety Procedures for Phosphorus-32 Use in Millicurie Amounts:

1. When stock solutions containing more than 1 millicurie of ^{32}P are used the following shielding and work station setups should be also be used.

   a. A plexiglass storage container of at least 1/8th inch thickness on all sides. A lead foil outer covering is desirable although not required.

   b. For working situations when sample is to be removed from the concentrated radioisotope, the container can be secured by placing it into a block of wood, with hole drilled to hold the isotope container.

   c. All work should be performed behind a standard plexiglass shield, and if any of the solutions are volatile, in a working hood.

   d. The surface of the working area should be covered with absorbent paper backed with a plastic water-proof sheet. Areas where isotope contaminated instruments are to be laid, should be marked ahead of time.

   e. A suitable waste container must be prepared and ready for use prior to the start of the experiment. It must be well labeled to avoid confusion with non-radioactive trash, and be properly disposed of according to radioactive waste guidelines set forth by the University's RSC in accordance with State and Federal regulations (RSC 9-89-E).

2. Monitoring devices may include:

   a. A finger ring monitor covered with disposable plastic glove if amounts above 5 millicuries will be handled at one time.

   b. A standard whole body monitor.

   c. A hand held Geiger counter must be present to conduct pre- and post-experiment surveys, as well as during the experiment to monitor spills and progress.

   d. Finally after the experiment is finished, and the hand held instrument has shown no contamination, wipe tests of the work area, and surrounding floor should be performed at least once per month and the results recorded.

3. Protective clothing should be worn, including a lab coat, disposable plastic gloves, and if quantities over 10 mCi of ^{32}P isotope are used, then protective eye coverings of snug fitting goggles must be worn during the time that this amount of isotope is being handled.

4. Prior to any actual use of radioisotope in first-time procedures, a dry run should take place using similar containers and equipment with water for isotope, to identify any potential trouble spots before real isotope is used.
5. If any spills occur they should be immediately attended to by standard emergency procedures, until they are contained, and the area is decontaminated.

RSC 10-19I

Laboratory Animal Facilities

The Department of Laboratory Animal Resources provides total care and management for two facilities on campus.

1. Skaggs Facility

   The Pharmacy/Psychology facility is located in the basement of the Skaggs building. It is a single corridor plan which consists of eight self-contained multi-purpose animal rooms, a service area and an administrative office. Adjacent to the animal areas is a food storage area and a surgery suite. This facility is equipped with a cage washer, automatic watering systems, and a HVAC system which allows for a 100% fresh, non-recirculated, humidity controlled air supply to each animal room.

2. Health Science Facility

   The Health Science facility is located in the basement of the Health Science building. This single-corridor facility contains ten multi-purpose animal rooms, an office, a sterile surgery suite, two cage-wash rooms and several equipment storage areas. It is equipped with a cage-washer and steam gun for cage sanitization. The facility also has several autoclaves. The HVAC unit supplies 100% fresh, non-recirculated air to each animal room. Each room is equipped with a light timer, sink, floor drain and ante-room.

Guidelines for the Use of Radioactive Materials

in Animals

1. All use of radioactive materials in animals must be by or under the direct supervision of an Authorized User who has a current Use Proposal approved by the Radiation Safety Committee (RSC), and who has submitted a supplemental data sheet detailing the proposed work involving administration of radioactive materials to animals.

2. If vertebrate animals are to be used, the Authorized User must file an Animal Use Form with the campus animal use committee, Institutional Animal Care and Use Committee (IACUC). A copy of this notice should be attached to the application for radionuclide use.

3. Outside doors to animal rooms in which radioactive material is present in quantities equal to or exceeding the quantities listed in the following table MUST be posted with a sign bearing the radiation hazard symbol and the words `CAUTION---RADIOACTIVE MATERIAL.'

Isotope	Posting Quantity (uCi)	Isotope	Posting Quantity (uCi)
^{3}H	10,000	^{65}Zn	100
^{14}C	1,000	^{75}Se	100
^{18}F	10,000	^{85}Kr	1,000
^{24}Na	100	^{85}Sr	100
^{32}P	100	^{86}Rb	100
^{35}S	1,000	^{87m}Sr	100
^{42}K	100	^{99m}Tc	1,000
^{43}K	100	^{113m}In	1,000
^{45}Ca	100	^{125}I	10
^{46}Sc	100	^{131}I	10
^{47}Ca	100	^{133}Xe	1,000
^{51}Cr	10,000	^{197}Hg	1,000
^{57}Co	100	^{198}Au	1,000
^{59}Fe	100	^{201}Tl	1,000

Check with RSC for posting limits for isotopes other than those listed above.

4. All live animals which have received radioactive materials and which are returned to an animal care facility must be properly identified. Each animal cage or pen must bear a cage card giving the investigator's name, isotope used, activity administered, and the date of administration.

5. Animals that have received radioactive material must be transported in such a manner as to prevent any contamination of hallways, elevators, etc. Solid bottomed transfer containers are MANDATORY. Such animals may not be transported across public streets or sidewalks except by the RSO.

6. The potential hazard to animal caretakers and other persons entering the animal room must be evaluated before work begins. This evaluation must be based on the radiation

dose rate in the work place, the excretion rate of the radioactive material, and any special hazard that may be associated with the radionuclide or its chemical form. Some examples of this include consideration of the volatility of iodine compounds or the anticipated very low excretion rate of microspheres.

7. The Manager of Laboratory Animal Resources must be notified in advance of the housing needs for radioactive animals. Written protocols for both routine and emergency situations with regards to animal care and handling must be included in the Proposal for the Use of Live Animals in Research and Teaching form (RA-104). Routine care includes feeding, watering, cage cleaning, and the collection and labeling of radioactive animal wastes. Standardized protocols are available and must be used whenever animals are returned to general animal care facilities. Emergency or special situations include those requiring intervention by other personnel, such as post-op care, administration of medications, etc.

8. Cage/pen wastes (i.e., animal excreta and bedding) must be collected in plastic-lined brown bags, sealed with radiation tape, labeled with the Authorized User's name, Nuclide(s), total collected activity and date. These bags must be stored in a designated radioactive animal freezer. Notify the RSO for pick up and disposal as radioactive waste.

9. Carcasses and tissues removed from animals must be frozen and stored in designated freezers until they can be disposed of by the RSO as solid radioactive waste. Carcasses must be placed in two opaque bags, sealed with radioactive tape, labeled with the Authorized User's name, Nuclide(s), total activity in carcass, and the date administered. All labels must also be on the outside of the outermost bag.

10. All carcasses must be stored in an appropriate freezer (one labeled for use with radioactivity) and notify the RSO for pick up and disposal as radioactive waste.

Standard Protocols for Care of Animals Containing Radioactive Material

1. INTRODUCTION

Authorized users who require care for animals treated with radioactive materials must provide complete written instructions as to the procedures which must be followed with respect to cage handling and collection and disposal of radioactive waste. This information must be included in the Proposal for the Use of Live Animals in Teaching and Research (form RA-104). When possible, separate areas within the animal facility will be made available for radioactive animal studies. For some levels of radioactivity isolation is not specifically required, but clear labeling of the radioactive hazard and its level must be performed. All investigators using radioisotopes are required to design and execute a protocol to assure that any necessary exposures as low as reasonably achievable. This requirement also applies to animal care and the use of animal-care facilities.

To assist investigators who must maintain animals treated with radioactive material, RSC (Radiation Safety Committee) and the LAR (Laboratory Animal Resources) have developed a set of five standard protocols for animal care. The protocols specify the radiation conditions permitted for their use, personal hygiene precautions to be taken by animal-care personnel and instructions for cage cleaning and the collection, labeling, and disposal of radioactive wastes. Cage cards will be maintained on all cages. Side 1 of each card lists information concerning the user, radioisotope administered, and protocol level of animal care. Side 2 lists information needed for the radioactive waste record. Each investigator, regardless of the animal facility used, retains full responsibility for providing written protocols covering emergency and special situations that may arise with the animals.

2. SELECTING LOCATION FOR PROVIDING ANIMAL CARE

The decision on whether animals containing radioactive material may be housed in general animal-care facilities or if they must be placed in isolation rooms depends in part on the radio toxicity of the radionuclide(s) being used and the maximum activity excreted daily per cage per room. Radio toxicity classifications and maximum daily excretion limits for commonly used radionuclides are summarized in the following two tables.

Radio toxicity Classification

Hazardous	Ca-45,	Sc-46,	I-123,	I-125,	I-131	
Moderately Hazardous	Na-22, Fe-59, T1-201	P-32, Zn-65,	S-35, Se-75,	K-42, Sr-85,	Ca-47, Hg-197,	Co-57, Au-198,
Slightly Hazardous	C-14, Tc-99m,	F-18, In-113m,	Cr-51 Xe-133.	Kr-85, H-3	Sr-87m,	

Maximum Permitted Daily Activity Excreted

Radio toxicity Classification	Housed in General Animal Rooms		House in Isolation Rooms
	Care provided by non-radiation workers	Care provided by radiation workers	Care provided by radiation workers
Hazardous	<100 uCi per cage and <500 uCi per room	>100 uCi per cage but >500 uCi per room	<500 uCi per room
Slightly Hazardous	<5 mCi per cage and <10 mCi per room	>5 mCi per cage or >10 mCi per room	>50 mCi per room

Check with the RSC for radio toxicity classifications and permitted quantities for radionuclides not listed above. Limits may be changed by RSC as necessary to maintain personnel radiation exposures as low as reasonably achievable.

3. APPLYING FOR AUTHORIZATION TO USE RADIOACTIVE MATERIAL IN ANIMALS.

Each investigator who wishes authorization to use radioactive material in animals must submit a written application to the RSC in addition to his/her standard Authorized User's Request Form 1 detailing the experiments proposed, where the animals will be housed, and the personnel responsible for their care as well as the written protocols covering normal and emergency and special situations that may arise with the animals.

In addition if the animals to be used are vertebrates, the investigator must also have approval for vertebrate animal use from the Institutional Animal Care and Use Committee (IACUC).

Work cannot begin until final approvals are provided from both the RSC and the IACUC.

Normal Protocols for Various Levels of Animal Care

1. Level I Protocol.

A. Conditions for Use.

1. No appreciable excretion of radioactive material can occur. Radioactivity in animal wastes is less than that calculated to be present after a time interval equal to 10 half lives of the radionuclide(s) involved.

2. Radiation dose rate in the normal work space around the animal(s) does not exceed 2 millirem per hour. The dose rate is to be measured at locations representative of the real work situation. Calculated conservative estimates of dose rates may be used in place of measured dose rates.

B. Personal Hygiene.

The following standard personnel practices apply to professional and technical staff, students and investigators working with laboratory animals, and others who are required to enter animal rooms to provide support services.

1. Laboratory coats are required to be worn by all persons entering an animal room. This protective clothing is to be removed before leaving the animal facility.

2. Disposable surgical masks and gloves are to be worn by anyone working with materials or spraying water in such a manner as to possibly aerosolize contaminants.

3. Eating, drinking, smoking or applying cosmetics is not permitted in the laboratory animal facility.

4. Washing hands with soap after handling laboratory animals is required before leaving the animal room.

5. Nothing is to be taken from one animal room to another without being sanitized, including cleaning tools, research equipment and restraint devices.

6. All injuries are to be reported to the Manager of Laboratory Animal Resources. Treatment for injuries due to direct animal contact (ie. bites, scratches etc.) will follow CDC recommendations which are located in the Office of Laboratory Animal Resources.

C. Animal Care.

1. Laboratory Animal Resource staff will provide all routine animal care, cage manipulation, and cleaning.
2. Treat animal waste and litter as ordinary solid waste.

D. Further Care.

1. Standard Protocol Level 1 is appropriate until the animal is sacrificed or re-exposed.
2. A new protocol level must be reassigned by the RSC each time an animal receives additional radioactive materials.

2. Level 2 Protocol

A. Conditions for Use.

1. Used only with short-lived radioisotopes (physical half life (T1/2 <= 10 hours)).
2. May not be appropriate with animals requiring daily cage cleaning unless the physical half-life of the radionuclide is less than 2.5 hrs.

3. Radiation dose rate in normal work space does not exceed 2 millirem per hour.

B. Personal Hygiene.
The following standard personnel practices apply to professional and technical staff, students and investigators working with laboratory animals, and others who are required to enter animal rooms to provide support services.

1. Laboratory coats are required to be worn by all persons entering an animal room. This protective clothing is to be removed before leaving the animal facility.
2. Disposable surgical masks and gloves are to be worn by anyone working with materials or spraying water in such a manner as to possibly aerosolize contaminants.
3. Eating, drinking, smoking or applying cosmetics is not permitted in the laboratory animal facility.
4. Washing hands with soap after handling laboratory animals is required before leaving the animal room.
5. Nothing is to be taken from one animal room to another without being sanitized, including cleaning tools, research equipment and restraint devices.
6. All injuries are to be reported to your the Manager of Laboratory Animal Resources. Treatment for injuries due to direct animal contact (ie. bites, scratches etc.) will follow CDC recommendations which are located in the Office of Laboratory Animal Resources.

C. Animal Care.

1. During the specified care period, feed and water the animals but do not clean the cage(s).
2. Clean cage(s) upon termination of study.
3. Treat animal waste and litter as ordinary solid waste.
4. The person cleaning the cage is to sign the cage card, noting date of cleaning.

D. Further Care.

1. Standard Protocol Level is appropriate until the animal is sacrificed or re-exposed.
2. A new Protocol level must be reassigned by the RSC each time an animal receives additional radioactive material.

3. Level 3 Protocol.

A. Conditions for Use.

1. Radiation dose rate in normal work space does not exceed 2 millirem per hour.
2. Animal litter is contaminated and must be collected and stored as radioactive waste.
3. The quantity of radioactivity does not exceed the limits established by the RSC for non-radiation workers. These limits are based on the chemical and physical form of the radionuclide and its excretion rate.

B. Personal Hygiene.

The following standard personnel practices apply to professional and technical staff, students and investigators working with laboratory animals, and others who are required to enter animal rooms to provide support services.

1. Laboratory coats are required to be worn by all persons entering an animal room. This protective clothing is to be removed before leaving the animal facility.
2. Disposable surgical masks, gloves, and shoe covers are to be worn.
3. Eating, drinking, smoking or applying cosmetics is not permitted in the laboratory animal facility.
4. Washing hands with soap after handling laboratory animals is required before leaving the animal room.
5. Nothing is to be taken from one animal room to another without being sanitized, including cleaning tools, research equipment and restraint devices.
6. All injuries are to be reported to your the Manager of Laboratory Animal Resources. Treatment for injuries due to direct animal contact (ie. bites, scratches etc.) will follow CDC recommendations which are located in the Office of Laboratory Animal Resources.

C. Animal Care.

1. Cage cleaning:
   a. Use plastic lined paper bag to collect litter.
   b. Place paper on floor under litter bag to catch spilled litter.
   c. Scrape cages as clean as possible before sending them to the cage wash area.
   d. Place paper in litter bag.
   e. Discard disposable gloves in litter bag.
   f. Staple bag and seal with "Radioactive Material" tape.
   g. Label bag as "ANIMAL LITTER" and with "AUTHORIZED USER'S NAME, NUCLIDE, ACTIVITY COLLECTED, and DATE.
   h. Initial side 2 of cage card each day cage is cleaned.
   I. Store litter bags in freezer for radioactive materials.

2. Pen Cleaning.

   To Enter Animal Pen

   a. Place paper on floor outside pen.
   b. Place all supplies needed on paper.
   c. Use tools designated "**Radioactive**."
   d. Put on shoe covers and 2 pairs of gloves.
   e. Enter pen--do not let animal out of pen.
   f. Collect cage litter in plastic-lined paper bag.
   g. Scrape tools clean.

   To Leave Animal Pen.

   a. Place supplies on the paper outside pen.

b. Stand on paper, remove one shoe cover, step on floor and repeat with other foot.
c. Place shoe covers in litter bag.
d. Remove outer pair of gloves and place in litter bag.
e. Transfer supplies and equipment from the paper to their designated storage areas.
f. Roll up paper and place in litter bag.
g. Discard second pair of gloves in litter bag.
h. Staple bag and seal with "Radioactive Material" tape.
I. Label bag as "ANIMAL LITTER" and with "AUTHORIZED USER'S NAME, NUCLIDE, ACTIVITY COLLECTED, and DATE.
j. Initial side 2 of cage card each day cage is cleaned.
k. Store litter bags in freezer for radioactive materials.

D. Further Care.

1. Standard Protocol Level 1 is appropriate until the animal is sacrificed or re-exposed.
2. A new Protocol level must be reassigned by the RSC each time an animal receives additional radioactive material.

4. Level 4 Protocol

A. Conditions for Use.

1. The radioactivity exceeds the limits for non-radiation workers and/or the radiation dose rate in normal work space exceeds 2 millirem per hour.
2. The radiation dose rates in other work areas of the general animal room do not exceed 2 millirem per hour.
3. Animals may be stored in the general animal care facilities.
4. A trained radiation worker from the LAR staff provides all routine care of the animal for the designated care period. A record is kept identifying the person(s) who provides the animal care (side 2 of the cage card).

B. Personal Hygiene.

The following standard personnel practices apply to professional and technical staff, students and investigators working with laboratory animals, and others who are required to enter animal rooms to provide support services.

1. Laboratory coats are required to be worn by all persons entering an animal room. This protective clothing is to be removed before leaving the animal facility.
2. Disposable surgical masks, gloves, and shoe covers are to be worn at all times when in the animal room.
3. Eating, drinking, smoking or applying cosmetics is not permitted in the laboratory animal facility.
4. Washing hands with soap after handling laboratory animals is required before leaving the animal room.
5. Nothing is to be taken from one animal room to another, including cleaning tools, research equipment and restraint devices.

6. All injuries are to be reported to your the Manager of Laboratory Animal Resources. Treatment for injuries due to direct animal contact (ie. bites, scratches etc.) will follow CDC recommendations which are located in the Office of Laboratory Animal Resources.

C. Animal Care.

See Standard Protocol Level 3, for detailed cage/pen cleaning procedures.

D. Further Care.

1. When the radiation conditions drop to allowable levels for non-radiation workers, Standard Protocol Level 1 or 2, whichever is appropriate, is instituted.
2. A new protocol level must be reassigned by the RSC each time an animal receives additional radioactive material.

5. Level 5 Protocol.

A. Conditions for Use.

1. The degree of hazard requires isolation of the treated animal(s).
2. Access to the isolation room is restricted to necessary personnel only.
3. Arrangements for an isolation room must be made with LAR prior to the start of the experiment. The experiment may need to be delayed until a suitable room is available.
4. The investigator together with the RSO will determine the duration of the isolation and the next appropriate animal care protocol to be used.
5. A trained radiation worker from the LAR staff provides all routine care of the animal for the designated care period including cage washing and room cleaning. A record is to be kept identifying the person(s) who provides the animal care (side 2 of the cage card).
6. Decontamination of the room and equipment must be verified by the RSO before the Authorized User/Investigator is relieved of responsibility for the room.

B. Room Preparation.

1. Post isolation room with a "NO ENTRY" sign and a Level 5 cage card. These signs cannot be removed until the RSO clears the room in accordance with paragraph A6, above.

C. Personal Hygiene.

The following practices apply to professional and technical staff, students and investigators working with laboratory animals, and others who are required to enter animal rooms to provide support services.

1. Laboratory coats are required to be worn by all persons entering an animal room. This protective clothing is to be removed before leaving the animal facility.
2. Disposable surgical masks, gloves, and shoe covers are to be worn at all times when in the animal room.

3. Eating, drinking, smoking or applying cosmetics is not permitted in the laboratory animal facility.
4. Washing hands with soap after handling laboratory animals is required before leaving the animal room.
5. Nothing is to be taken from one animal room to another, including cleaning tools, research equipment and restraint devices.
6. All injuries are to be reported to your the Manager of Laboratory Animal Resources. Treatment for injuries due to direct animal contact (ie. bites, scratches etc.) will follow CDC recommendations which are located in the Office of Laboratory Animal Resources.

D. Animal Care.

1. A trained LAR radiation worker is responsible for all animal care including cage/pen cleaning and manipulation, collection and storage of cage litter as radioactive waste, and the routine feeding and watering of the animal(s).
2. See Standard Protocol Level 3, for detailed cage/pen cleaning procedures.
3. Decontamination
   a. Scrape cages and pens as clean as possible.
   b. Removable equipment may be transferred to the cage washing area and sanitized.
   c. All cleaned equipment will remain out of service until the RSO has verified its decontamination.
   d. All surfaces of the isolation room cleaned and sanitized.
7. Verifying Decontamination.
   a. Request the RSO to survey the cleaned isolation room and equipment.
   b. The RSO will notify the LAR supervisor and the Authorized User/Investigator of survey results and advise on any further actions required.

E. Further Care.

1. Animals may be returned to general animal care facility when the external radiation does rate and/or radioactivity in cage litter meets the lower levels set for general facilities (Standard Protocol Level 4).
2. Non-radiation LAR personnel may assume animal-care responsibilities when radiation conditions no longer exceed the radiation dose limits for non-radiation workers (Standard Protocol Levels 2 and 1).
3. The RSO will assist the LAR Manager with evaluation of radiation conditions and selection of the proper animal care standard protocol.
4. A new Protocol level must be reassigned by the RSC each time an animal receives additional radioactive material.

PORTABLE GAUGES

The University of Montana no longer has portable gauges.

^{14}C

(Carbon-14)

Physical Characteristics

Half Life:
Physical 5,730 years
Biological 10 days (whole body)
12 days (fat)
Effective 10 days (whole body)
12 days (fat)
Radiation Emitted: β^-
Energy of Radiation (keV): 156 (max) 48 (mean)
Maximum Range of Beta Particles:
Air 24mm
Water 0.28mm

Radiation Biology

Critical Organ: Whole body & fat

Toxicity: Medium/Low

Maximum Body Burden: 400 µCi (Whole Body) 300 µCi (fat)

Bioassay: Not routinely done. Urinalysis and breath analysis are possible.

Health Physics

MPC in Air (µCi/ml):

Restricted Area	4×10^{-6} (any form)	5×10^{-6} ($^{14}CO_2$)
Environment	1×10^{-7} (any form)	1×10^{-6} ($^{14}CO_2$)

Survey Technique:
Beta survey meter; thin window G-M survey meter; or wipes, counted by LSC. A 2inch G-M detector is only about 5% efficient with C14

Shielding Required:
None

Film Badge Required: No

Special Considerations: None

^{57}Co

(Cobalt-57)

Physical Characteristics

Half Life:

Physical	270.9 days
Biological	9.5 days
Effective	9.2 days

Radiation Emitted: γ & X-rays

Energy of Radiation (keV):

14 (9.5%)
122 (85.5%)
136 (10.8%)
570 (0.01%)
692 (0.16%)
607 (55%)
^{57}fE X-rays

Dose Rate at 1 meter from a 1mCi Point Source: 0.151 mR/hr

Radiation Biology

Critical Organ: Lower Large Intestine

Toxicity: Medium/Low

Maximum Body Burden: 200 µCi (Whole Body)

Bioassay: Not routinely done. Urinalysis is possible.

Health Physics

MPC in Air (µCi/ml):

Restricted Area	3×10^{-7}
Environment	1×10^{-7}

Survey Technique: Gamma or X-ray survey meter.

Shielding Required: 7.5 cm of lead provides 95% attenuation

Film Badge Required: Yes -- if working with large amounts

Special Considerations: None

^{51}Cr

(Chromium-51)

Physical Characteristics

Half Life:
Physical 27.7 days
Biological 616 days
Effective 26.6 days

Radiation Emitted: γ & X-rays

Energy of Radiation (keV):
320 (9.8%)
5 (22%)
^{51}V K-X-rays

Dose Rate at 1 Meter from a 1mCi Point Source: 0.023 mR/hr

Radiation Biology

Critical Organ: Whole body & Lower Large Intestine (LLI)

Toxicity: Medium/Low

Maximum Body Burden: 800 µCi (Whole Body)

Bioassay: Not routinely done. Urinalysis is possible.

Health Physics

MPC in Air (µCi/ml):
Restricted Area 1×10^{-5}
Environment 4×10^{-7}

Survey Technique: Gamma or X-ray survey meter

Shielding Required: 7.8 mm lead provide 95% attenuation.

Film Badge Required: Yes -- if working with large amounts

Special considerations: None

^{3}H

(Hydrogen-3; Tritium)

Physical Characteristics

Half Life:

Physical	12.3 years
Biological	12 days
Effective	12 days

Radiation Emitted: β^-

Energy of Radiation (keV): 18.6 (max) 5.7 (mean)

Maximum Range of Beta Particles:

Air	5 mm
Water	0.006 mm

Radiation Biology

Critical Organ: Whole Body

Toxicity: Low

Maximum Body Burden: 1,000 µCi

Bioassay: Urinalysis required within 10 working days after working with 25 mCi or more of organically bound tritium or with 100 mCi or more of tritiated water or sodium borohydride.

Health Physics

MPC in Air (µCi/ml):

Restricted Area	2×10^{-3} ($^{3}H_x$)	5×10^{-6} ($^{3}H_2O$)	
Environment	4×10^{-5} ($^{3}H_2$)		2×10^{-7} ($^{3}H_2O$)

Survey Technique:

Wipes, counted by LSC

Shielding Required: None **Film Badge Required:** No

Special Considerations:

Tritium cannot be monitored directly because of the low beta energy. Special care is needed to control contamination. Regular monitoring by wipe testing is advisable. External contamination does not cause a radiation dose itself but can lead to potentially hazardous internal contamination and can interfere with experimental results.

^{125}I

(Iodine-125)

Physical Characteristics

Half Life:

Physical	60.1 days	
Biological	138 days (Whole Body)	138 days (thyroid)
Effective	41.8 days (Whole Body)	41.8 days (thyroid)

Radiation Emitted: γ & X-rays

Energy of Radiation (keV):

35 (7% emitted, 93% converted)
27-32 (138%, Te-X-rays)

Dose Rate at 1 meter from a 1mCi Point Source: 0.275 mR/hr

Radiation Biology

Critical Organ: Thyroid

Toxicity: Medium/High

Maximum Body Burden: 6.0 µCi (whole body)

Bioassay: Routine thyroid counts required whenever work with unsealed radioiodine in amounts greater than --

VOLATILE FORM	
Open Bench	1 mCi
Fume Hood	10 mCi
Glove Box	100 mCi
BOUND TO NON-VOLATILE COMPOUND	
Open Bench	10 mCi
Fume Hood	100 mCi
Glove Box	1,000 mCi

Bioassay: Will normally be required whenever work with unbound >5mCi in a fume hood or >1mCi on an open bench so as to maintain exposures ALARA.

Health Physics

MPC in Air (µCi/ml):

Restricted Area	5×10^{-9}
Environment	8×10^{-11}

Survey Technique: Low energy Gamma or X-ray scintillation-type survey meter.

Shielding Required: 0.8 mm of lead provides 95% attenuation

Film Badge Required: Yes -- whole body and ring if quantities are high (see manual)

Special Considerations: Volatilization is a most significant problem. Simply opening a vial of sodium iodide can cause significant airborne release. Breathing zone and exhaust effluent monitoring may be required. Solutions should not be made acidic or stored frozen. Double gloving strongly recommended. Notify RCS immediately if personnel contamination is suspected. Medical consultation may be needed. Neutralize all spills with sodium thiosulfate before starting clean-up. All work is normally to be done in an approved hood. Depending on activity used, supplemental "mini hoods," glove boxes, and/or in-line exhaust filters may be required.

^{131}I

(Iodine-131)

Physical Characteristics

Half Life:

Physical	8.0 days	
Biological	138 days (whole body)	7.6 days (thyroid)
Effective	7.6 days (whole body)	7.6 days (thyroid)

Radiation Emitted: β & γ

Energy of Radiation (keV):

β - 806 (max) 180 (mean)
γ - .80 (2.4%)
284 (5.9%)
364 (81.8%)
637 (7.2%)
723 (1.8%)

Dose Rate at 1 meter from a 1mCi Point Source: 0.283 mR/hr

Radiation Biology

Critical Organ: Thyroid

Toxicity: Medium/High

Maximum Body Burden: 50 µCi (whole body) 0.14 µCi (thyroid)

Bioassay: Routine thyroid counts required whenever work with unsealed radioiodine in amounts greater than -

VOLATILE FORM	
Open Bench	1 mCi
Fume Hood	10 mCi
Glove Box	100 mCi
BOUND TO NON-VOLATILE COMPOUND	
Open Bench	10 mCi
Fume Hood	100 mCi
Glove Box	1,000 mCi

Bioassay: Will normally be required whenever work with >5 mCi in a fume hood or >1m Ci on an open bench so as to maintain exposures ALARA (if material is unbound).

Health Physics

MPC in Air (µCi/ml):

Restricted Area	9×10^{-9}
Environment	1×10^{-10}

Survey Technique: Beta or Gamma survey meter.

Shielding Required: 12.4 mm of lead provides 95% attenuation

Film Badge Required: Yes -- whole body and ring (see manual)

Special Considerations: Volatilization is a most significant problem. Simply opening a vial of sodium iodide can cause significant airborne release. Breathing zone and exhaust effluent monitoring may be required. Solutions should not be made acidic or stored frozen. Double gloving strongly recommended. Notify RCS immediately if personnel contamination is suspected. Medical consultation may be needed. Neutralize all spills with sodium thiosulfate before starting clean-up. All work is normally to be done in an approved hood. Depending on activity used, supplemental "mini hoods," glove boxes, and/or in-line exhaust filters may be required.

^{54}Mn

Manganese-54)

Physical Characteristics

Half Life:

Physical	312.7 days
Biological	17 days
Effective	5.6 days

Radiation Emitted: γ & ε

Energy of Radiation (keV):
Y - 835 (100%)
ε - 829

Dose Rate a 1 meter from a 1 mCi Point Source: 0.511 mR/hr

Radiation Biology

Critical Organ: LLI, Liver, Lung

Toxicity: Medium/High

Maximum Body Burden: 20 µCi (Liver)
40 µCi (Whole Body)

Bioassay: Not routinely done. Urinalysis is possible.

Health Physics

MPC in Air (µCi/ml):

Restricted Area	4×10^{-8}
Environment	1×10^{-9}

Survey Technique: Gamma or X-ray survey meter.

Shielding Required: 3.2 cm of lead provides 95% attenuation

Film Badge Required: Yes -- whole body. Ring also required if handling over 0.5 mCi.

Special Considerations:
Rigid contamination control and laboratory survey procedures are required, especially when using "gamma microspheres."

Use of syringe shields is highly recommended.

Floor drains should be sealed when using gamma microspheres.

^{32}P

(Phosphorus-32)

Physical Characteristics

Half Life:

Physical	14.3 days
Biological	257 days (whole body)
	1,157 days (bone)
	18 days (liver)
	257 days (brain)
Effective	13.5 days (whole body)
	14.1 days (bone)
	8 days (liver)
	13.5 days (brain)

Radiation Emitted: β & Bremsstrahlung
Energy of Radiation (keV): 1,709 (max) 690 (mean)

Maximum Range of Beta Particles:

Air	780 cm
Water	0.8 cm

Radiation Biology

Critical Organ: Bone

Toxicity: Medium/Low

Maximum Body Burden:
30 µCi (whole body)
6 µCi (bone)

Bioassay: Not routinely done. Urinalysis is possible.

Dose Rate at 1 Meter from a 1mCi Point Source: 0.091 mR/hr

Dose Rate on Contact with 1mCi: 78,000 mR/h

Health Physics

MPC in Air (µCi/ml):

Restricted Area	7×10^{-8}
Environment	2×10^{-9}

Survey Technique: Beta survey meter.
Shielding Required: 1 cm plexiglass and lead
FIlm Badge Required: Yes -- whole body and ring if amounts and duration warrant
Special Considerations:
Highest energy radionuclide commonly used in research labs. IN addition to good lab practices, use of leaded rubber gloves may be appropriate. Also, absorption of high energy Beta by low density materials gives rise to high intensity Bremsstrahlung which requires lead shielding, particularly when 10mCi or more is present. Always remember that extremely high radiation exposures, especially to the hands, can occur from even short exposures to small quantities.
Wear lab coats and protective glasses. Also "double gloving" is strongly encouraged.
Every individual working with ^{32}P is required to survey himself/herself and the workplace with an appropriate survey instrument immediately at the end of work.
Because it is a bone seeker, special care must be taken to minimize any chance of introducing this isotope into the body.

^{35}S

(Sulfur-35)

Physical Characteristics

Half Life:

Physical	87.4
Biological	90 days (whole body)
	623 days (testis)
Effective	44.3 days (whole body)
	76.4 days (testis)

Radiation Emitted: β

Energy of Radiation (keV): 167 (max) 49 (mean)

Maximum Range of Beta Particles:

Air	30 mm
Water	0.28 mm

Radiation Biology

Critical Organ: Whole Body & Testis

Toxicity: Medium/Low

Maximum Body Burden: 400 µCi

Bioassay: Not routinely done.

Health Physics

MPC in Air (µCi/ml):

Restricted Area	3×10^{-7}
Environment	9×10^{-9}

Survey Technique:

Beta survey meter; thin window G-M survey meter; or wipes, counted by LSC. A 2 inch G-M detector is approximately 5% efficient at detecting S35

Shielding Required:

1 cm plexiglass (3 mm would be OK, but has poor mechanical properties). Unless large quantities are used shielding is not required.

Film Badge Required: No

Special Considerations: None

^{65}Zn
(Zinc-65)

Physical Characteristics

Half Life:

Physical	244.4 days
Biological	933 days
Effective	194 days

Radiation Emitted: β^+, ε^-, & γ

Energy of Radiation (keV):
β^+ - 327 (max)
ε^- - 1,106
γ - 511 (0.4%)
1,155 (49%)

Radiation Biology

Critical Organ: Whole Body, Prostate, Liver

Toxicity: Medium

Maximum Body Burden:
60 µCi (Whole Body)
70 µCi (Prostate)
80 µCi (Liver)

Bioassay: Not routinely done. Urinalysis is possible.

Health Physics

MPC in Air (µCi/ml):

Restricted Area	6×10^{-8}
Environment	2×10^{-9}

Survey Technique: Gamma or X-ray survey meter
Shielding Required: 4.06 cm of lead provides 95% attenuation
Film Badge Required: Yes--whole body. Ring also required if handling over 0.5 mCi

Special Considerations:
Rigid contamination control and laboratory survey procedures are required, especially when using "gamma microspheres."

Use of syringe shields is highly recommended.

Floor drains should be sealed when using gamma microspheres.

RADIATION SAFETY MANUAL

Emergency Response Procedures

University of Montana

Major Spills, Contaminations, Injuries with Radioactive Materials must be reported to the following contacts:

Kay Altenhofen, Radiation Safety Officer
Phone – **243-7803**
Cell phone – **544-1636**

Keith Parker, Chair, Radiation Safety Comm.
Phone – **243-4235**
Home phone -549-7030

University Emergency number - **4000**

Emergency Responses Summary:

1. If spill or contamination involves injury administer first aid.
2. If spill is on the skin, flush thoroughly, on clothing discard.
3. If accident involves gases notify persons to vacate area; shut off hoods and fans if possible, seal area, and post warning.
4. Take immediate steps to decontaminate personnel involved.
5. Monitor all persons involved in the spill and cleanup.
6. Contact the Radiation Safety Officer or Safety Committee Chairman
7. Permit no person to resume work in the area until a survey has been made and approval of the Radiation Safety Officer is secured
8. Prepare the Spill Investigation form of the accident for the RSO.

STUDENT HEALTH SERVICE phone **2122**.

Minor Spills of Liquids and Solids

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.
- Report the incident to the Radiation Safety Officer (RSO) promptly.
- Allow no one to return to work in the area unless approved by the RSO.
- Cooperate with the RSO and/or the RSO's staff (e.g., investigation of root cause, provision of requested bioassay samples).
- Follow the instructions of the RSO and/or the RSO's staff (e.g., decontamination techniques, surveys, provision of bioassay samples, requested documentation).

Reminders to RSO

- Follow up on the decontamination activities and document the results.
- As appropriate, determine cause and corrective actions needed; consider bioassays, if there is a potential for internal contamination.
- If necessary, notify NRC.

Major Spills of Liquids and Solids

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.
- Notify the RSO immediately.
- 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 the RSO and/or the RSO's staff (e.g., investigation of root cause,

provision of requested bioassay samples).
- Follow the instructions of the RSO and/or the RSO's staff (e.g., decontamination techniques, surveys, provision of bioassay samples, requested documentation).

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 is suspected to have been ingested, inhaled, or absorbed through or injected under the skin.
- If necessary, notify NRC.

Incidents Involving Radioactive Dusts, Mists, Fumes, Organic Vapors, and Gases

Instructions to Workers

- Notify all personnel to vacate the room immediately.
- Shut down ventilation system, if possible, unless it is determined that the room ventilation system needs to be used to clear the air for access purposes.
- Vacate the room. Seal the area, if possible.
- Notify the RSO immediately.
- 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.
- 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 the RSO and/or the RSO's staff (e.g., investigation of root cause, provision of requested bioassay samples).
- Follow the instructions of the RSO and/or the RSO's staff (e.g., decontamination techniques, surveys, provision and collection of bioassay samples, requested documentation).

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 is suspected to have been ingested, inhaled, or absorbed through or injected under the skin. Document incident.
- If necessary, notify NRC.

Minor Fires

Instructions to Workers

- Immediately attempt to put out the fire by approved methods (e.g., fire extinguisher) if other fire hazards or radiation hazards are not present.
- Notify all persons present to vacate the area and have one individual immediately call the RSO and fire department (as instructed by RSO).
- 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 with lukewarm water, then washing with a 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 the RSO and/or the RSO's staff (e.g., investigation of root cause, provision of requested bioassay samples).
- Follow the instructions of the RSO and/or the RSO's staff (e.g., decontamination techniques, surveys, provision of bioassay samples, requested documentation).

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 is suspected to have been ingested, inhaled, or absorbed through or injected under the skin. Document incident.
- If necessary, notify NRC.

Fires, Explosions, or Major Emergencies

Instructions to Workers

- Notify all persons in the area to leave immediately.
- Notify the fire department.
- Notify the RSO and other facility safety personnel.
- Upon arrival of firefighters, inform them where radioactive materials are stored or where radioisotopes were being used; inform them of the present location of the

licensed material and the best possible entrance route to the radiation area, as well as any precautions to avoid exposure or risk of creating radioactive contamination by use of high pressure water, etc.

- Cooperate with the RSO and/or the RSO's 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 and/or the RSO's staff (e.g., decontamination techniques, surveys, provision of bioassay samples, requested documentation).

Reminders to RSO

- Coordinate activities with facility's industrial hygienist or environmental health & safety office, and with local fire department.
- Consult with the firefighting personnel and set up a controlled area where the firefighters can be surveyed for contamination of their protective clothing and equipment after the fire is extinguished.
- Once the fire is extinguished, advise the firefighters not to enter potentially contaminated areas or areas where radioactive sources may be present until a thorough evaluation and survey are performed to determine the extent of the damage to the licensed material use and storage areas.
- Perform thorough contamination surveys of the firefighters and their equipment before they leave the controlled area and decontaminate, if necessary.
- Supervise decontamination activities.
- Consider bioassays if licensed material is suspected to have been ingested, inhaled, or absorbed through or injected under the skin. Document incident.
- If necessary, notify NRC.