Uppsala University

Department of Bioorganic Chemistry

Radiation Safety User's Guide

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Radiation Safety User's Guide

Introduction: This guide was written to give a better understanding of radiation safety issues at the Department of Bioorganic Chemistry, Uppsala University, and management of the program in compliance with state regulations and University policy. This guide is based on the *University of Arkansas Radiation Safety Manual* and an exchange of ideas with authorized users and experts in this area.

Objectives: The goal of the guide is to assist researchers in the application of the Uppsala University radiation safety program in their laboratories. It serves as a quick reference to provide instruction to workers regarding the safe use of radioactivity.

Overview of the radiation safety program (except X-ray program) in campus:

The most commonly used isotopes on the Uppsala University campus are shown in Table 1. Most of the isotopes are purely β- emitters. I-125 is only used in the Animal and Poultry Science building. The isotopes Cs-137 and Ba-133 are used as an external source in liquid scintillation counters (LSC).

Table 1: Commonly Used Radioactive Materials on Uppsala University campus:

Isotope	***Decay mode***	***Half life***
Tritium (H-3)	β^-	***12.3 years***
Carbon 14 (C-14)	β^-	***5730 years***
Phosphorus 32 (P-32)	β^-	***14.3 days***
Phosphorus 33 (P-33)	β^-	***25.3 days***
Sulfur 35 (S-35)	β^-	***87.4 days***
Iodine 125 (I-125)	γ	***59.6 days***
Cesium 137 (Cs-137)	β^-	***30.23 years***
Nickel 63 (Ni-63)	β^-	***96 years***
Strontium 90 (Sr-90)	β^-	***21.8 years***
Barium 133 (Ba-133)	γ	***10.5 years***

I. General Rules

The following are general rules intended to prevent internal exposure to radiation by the ingestion of radioactive materials, to provide for the security of radioactive materials against loss or theft, and to assure that members of the general public are not unnecessarily exposed to radiation as a consequence of the research activities of the laboratory.

1. Do not eat, drink, smoke or apply cosmetics in laboratory areas.

2. Do not store food or beverages in laboratory refrigerators or storage areas.

3. Wear a laboratory coat when working with radioactive materials, and leave it in the laboratory when work is completed.

4. Wear your personal dosimeter (i.e. film badge, finger ring) when applicable.

5. *Never* pipette radioactive materials using mouth suction.

6. Wear protective gloves when working with radioactive materials.

7. Work in a fume hood when using potentially volatile materials (i.e. **Sulfur-35)**.

8. When radioactive material is in use, it *must* be kept under surveillance. If it is not in use, it *must* be secured in a locked cabinet, box or refrigerator. The door(s) of any laboratory room containing *any amount* of unsecured radioactive material *must* be locked if no one is present.

9. Radioactive waste must not be placed in waste containers intended for non-radioactive trash, in any amount.

10. Radioactive waste must not be discharged into the sanitary sewer without approval of the Radiation Safety Officer. (Natalia Pavlenko, strålskyddskemist , Uppsala biomedicinska centrum (BMC), E-post: Natalia.Pavlenko@bmc.uu.se, Telefon:018-471 40 80).

11. Individuals working with radioactive iodine in any form shall have thyroid burden measurements performed.

II. Training of Laboratory Workers

Each lab must maintain documentation for each of the following required trainings for review by the Radiation Safety Officer.

1. All new laboratory workers that work with radioactive materials or radiation sources must complete 'Radiation Safety Orientation for Laboratory Workers' before they can begin working with radioactive materials. This is a *one-time* requirement. The Safety Officer offers this training periodically on the need-to-know basis.

2. All Authorized Users will provide on-the-job instructions specific to the need of this Laboratory and ensure that each worker is familiar with written laboratory procedures and the institutional policies.

III. Personnel Dosimetry (Film Badges)

Personnel working in research laboratories in the University are monitored with whole-body dosimeters and/or finger ring dosimeters. Dosimeters are generally issued and returned on a quarterly basis.

1. Laboratories using the Cesium-137 (Cs-137), Chromium-51 (Cr-51), Iodine-125 (I-125), or other gamma emitters are issued whole-body dosimeters, unless directed otherwise by Radiation Safety Officer (Natalia Pavlenko*, Strålskydd* , Uppsala biomedicinska centrum (BMC), E-post: Natalia.Pavlenko@bmc.uu.se, Telefon:018-471 40 80)

2. Laboratories using Phosphorus-32 (P-32) or other energetic beta emitters are issued whole-body and finger ring dosimeters, unless otherwise directed by Radiation Safety Officer.

3. Laboratories using *only* tritium (H-3), Carbon-14 (C-14), Phosphorus-33 (P-33), Sulfur-35 (S-35) and/or Calcium-45 (Ca-45) do not require external personnel monitoring and will not be issued badges.

4. **Note***: If members of a laboratory typically accrue less than 2% of the applicable occupational dose limits (less than 100 mrem deep dose or 1,000 mrem extremity dose) for a 12-month period, they may have their dosimeters discontinued. Communication with the laboratory must confirm that there are no anticipated changes in the types and amounts of radioactive materials used in experiments, or major changes in experimental protocols. If such changes are anticipated, personnel monitoring may be restored. The RSO will justify cancellation or restoration of the dosimetry program in the lab.*

IV. Ordering Radioactive Material

The following procedures for ordering radioactive material will be followed:

1. All orders for radioactive material will be approved by the Prefect and/or Radiation Safety Officer.

5. All shipments are delivered to the organic chemistry laboratory. All purchases should be registered in our central database of chemicals located at boc9 computer in room B9:530b and write a record in the "Purchase list of chemicals" journal located in room B9:530b

V. Receiving Radioactive Material Shipments

Upon receiving shipments of radioactive material in the laboratory, these procedures will be followed:

1. The package should be received by a person who is knowledgeable about the receipt, storage and security of radioactive material.

2. Before opening the outer package, put on protective gloves. Inspect the shipping papers and the identification information on the inner vial.

3. Verify that the contents of the inner package agree in name and quantity with the information on the packing slip.

4. If the stated contents of the shipment vial do not match the information on the shipping papers, or the shipment is otherwise defective, notify the supplier.

5. Store the material in a secure location. Radioactive material shall be locked up when not in use.

6. Survey the packing material. If no activity is detected, obliterate all radiation symbols and discard or recycle as normal trash.

VI. Performing Laboratory Surveys

Frequency of Laboratory Surveys

In order to ensure compliance with state regulations, survey the work and storage areas (including waste storage areas) **after each lab experiment** utilizing isotopes. Make sure to record results of the surveys in lab records. If no work with isotopes has been performed and previous swipes/surveys indicate no contamination, enter "no use" in place of survey data monthly. If a lab used multiple isotopes in one day, swipes/surveys can be taken at the end of the usage.

Control of Contamination

Contamination is radioactive material that has been spilled or otherwise inadvertently removed from its container into the environment. Contamination represents both an external hazard (from gamma and high-energy beta emitters) and an internal hazard (from ingestion or inhalation). This section reviews the principles of detecting and assessing contamination from radioisotopes used in this laboratory.

Performing Area Surveys with Geiger-Mueller (GM) Survey Meters

Surface contamination of most radioactive materials can be located easily by scanning with a GM meter equipped with a thin-end window or pancake detector. Upon finding a contaminated spot, a wipe or smear of the area counted in an appropriate counting system (usually a liquid scintillation counter) will determine removable activity. In general, energetic beta emitters like **Phosphorus-32** can be detected with a GM meter.

The presence of low energy beta emitters such as **Hydrogen-3, Carbon-14, Phosphorus-33, Sulfur-35** may be difficult to detect with a GM meter, therefore swipe tests should be used to determine the presence of possible contamination. These isotopes are difficult to detect with a GM meter due to the fact that the "window" of the detector may stop a significant number of the beta particles, depending on the energy. For example, Phosphorus-33 is detected with only about one-tenth the efficiency of Phosphorus-32. The efficiency of GM tubes for Sulfur-35 and Carbon-14 may be even less, depending on the thickness of the window. Hydrogen-3 cannot be detected at all by an area survey using a GM detector, and surface wipes must be used to detect its presence.

Area surveys shall be performed after each use of radioactivity, with the exception of Hydrogen-3. Laboratory coats, hands and shoes should be surveyed in addition to work surfaces.

Procedures to Follow When Performing Area Surveys

Perform battery checks on the survey meter. If acceptable, set to the most sensitive scale and proceed scanning the work area. For gamma emitters, scan with the probe window approximately 1 inch (2-3 cm) from the work surface. If contamination is detected, proceed with swipe tests (see below). For high energy beta emitters (**Phosphorus-32**), scan the work area with the probe window approximately 1/2 inch (1 cm) from the work surfaces. If contamination is detected, proceed with swipe tests.

Removable Contamination ("swipe") Survey

Wipe surveys will be performed under the following circumstances: (1) whenever and wherever contamination is likely to have occurred, or (2) at intervals as described under Frequency of Laboratory Surveys.

The presence of low energy beta emitters such as **Hydrogen-3, Carbon-14, Phosphorus-33, Sulfur-35** may be difficult to detect with a GM meter, therefore swipe tests should be used to determine the presence of possible contamination.

Procedures to Follow When Performing Surface Swipe Surveys

Radioactive material labeling may be conducted ONLY in the dedicated room at the Department of Cell and Molecular Biology and the enzymatic reactions are conducted at room B9:520b at the bench labeled with the "Radioactivity" sign. Swipe surveys should be performed on areas such as workbenches, sinks, refrigerator door handles and floors where radioactive material is used or stored.

Take swipes on benches and floor surfaces at locations indicated on the laboratory floor plan. Use dry filter paper circles, cotton-tipped swabs or other materials approved by the RSO. Label each swipe with the location code identified on lab floor plan; then rub an area approximately 100 cm^2 (about 4 x 4 inches). Count the swipes in the appropriate instrument and calculate net activity in disintegrations per minute (dpm). If this laboratory is equipped with counters that measure dpm directly, then the net activity is simply the gross dpm minus background dpm.

Note: Refer to manufacturer's documentation on the instrument for the correct calibration factors to convert cpm to dpm.

Action Levels for Contamination:

If amounts of contamination in excess of "two times above background levels" are detected, the area must be decontaminated. Keep all records of swipe results before and after decontamination.

Maintaining Records of Laboratory Surveys

Radioactive material labeling may be conducted ONLY in the dedicated room at the Department of Cell and Molecular Biology and the enzymatic reactions are conducted at room B9:520b at the bench labeled with the "Radioactivity" sign. This area used will be used to indicate where routine numbered swipe tests are to be performed. Routine swipe results will be recorded and stored in an easily accessible manner. Records must include the following:

1. Location, date and identification of equipment used, including the serial number and pertinent counting efficiencies.
2. Name of person conducting the survey.
3. Drawing of area surveyed, identifying relevant features such as active storage areas, active waste areas, etc.
4. Measured exposure rates, keyed to location on the drawing (point out rates that require corrective action).

5. Detected contamination levels, keyed to locations on drawing.
6. Corrective action taken in the case of contamination or excessive exposure rates, reduced contamination levels or exposure rates after corrective action, and any appropriate comments.
7. Maps/diagrams of all areas where contamination is found will be permanently maintained on file by the Radioactivity Safety Office/Safety Officer for the duration of the license.

VII. Spill Procedures

When any significant spill involving radioactive materials has occurred, the following general procedures will be followed:

1. Attend to any contaminated and/or injured personnel and remove them from the spill area.
2. Alert people in the immediate area of the spill and cordon/close off the spill area to exclude uninvolved personnel.
3. Notify the Prefect (tel. 081-4714577, local 4577, mobile 0704250243), Radiation Safety Officer (tel. 018-4714080, local 4080), the Safety Officer (tel. 018-4714578, local 4578, mobile 0707570739) or call **112** and report a "Radiological Emergency".

Specific procedures for decontaminating spills can be found in the corresponding Chemical Compound Data Sheet.

VIII. Radioactive Material Inventory

1. Each use of radioactive material will be documented by date, amount of isotope used, and amount remaining in storage container.
2. On a quarterly basis, the inventoried items will be reviewed, updated and submitted to Radiation Safety Officer by the Authorized User or his/her designee and a copy maintained for laboratory records.

IX. Radioactive Waste Disposal Procedures

Following are general considerations for managing radioactive waste.

1. Segregate radioactive materials by half-life and physical form. Liquid and solid waste must be collected separately. In addition, waste must be separated based on isotope's half-life (waste with isotopes with half lives

less than 90 days may be stored together and those with half lives more than 90 days may be stored together.) All liquid containers must have secondary containers to contain potential spills.
2. Sharps (needles, scalpels, broken glass, etc.) must be contained in puncture-resistant containers *before* being placed in waste barrels.
3. Do not place lead pigs in waste barrels.
4. Aqueous waste must be treated to attain a pH between 5 and 9 before disposal.
5. Liquid containers should be only 2/3 full and the cap should be tightly closed.
6. Gloves worn during the handling of radioactive materials will be removed before handling paperwork.
7. Wastes may be stored in a designated area of the lab until pick up disposed at the designated areas at the Department of Cell and Molecular Biology, BMC, Uppsala University.

X. Equipment, Renovations, and Closing Out the Laboratory

1. Liquid scintillation counters, gamma counters and certain gas chromatographs may contain radiation sources. These instruments should not be moved, transferred, sold or disposed of without first consulting the Radiation Safety Officer.
2. If a laboratory is to be closed or renovated, the Authorized User for the laboratory shall notify the Radiation Safety Officer of this fact **four weeks** prior to the anticipated closure date.
3. Before closure or renovation, all usable radioactive materials must be disposed of, transferred or secured elsewhere, and all radioactive waste must be removed from the laboratory rooms.
4. Suitability of return of the laboratory to general use must be documented as a non-contaminated area by survey (i.e. swipes/GM).

XI. Contact Information

Contact the Prefect (tel. 081-4714577, local 4577, mobile 0704250243), Radiation Safety Officer (tel. 018-4714080, local 4080), the Safety Officer (tel. 018-4714578, local 4578, mobile 0707570739) if you have any question.

To contact by fax, dial 018-55 44 95. To contact by phone, dial 018-4714577.

For **emergencies** or urgent issues outside normal business hours, contact the Prefect (tel. 081-4714577, local 4577, mobile 0704250243), Radiation Safety Officer (tel. 018-4714080, local 4080), the Safety Officer (tel. 018-4714578, local 4578, mobile 0707570739) or call **112** and report a “Radiological Emergency”.