Procedures for Use of Radioactive Material
Ordering, Unpacking, Storage, Handling, Disposal, Safety

Cane Research Group
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I. Introduction

The proper use of radioactive materials involves considerations of safety, proper scientific procedure, good housekeeping, and thorough record keeping. Familiarity with and knowledge of the required procedures is essential. Failure to follow the protocols required by our Radioactive Materials License and described below may lead to unnecessary health risks, both to the negligent individual and to co-workers, can seriously compromise the validity of everyone's experiments due to uncontrolled contamination, and could jeopardize our Radioactive Materials License. If you are uncertain about what procedures to follow, please contact Dr. Cane or the group member responsible for Radioisotope.

Official Brown University Procedures governing the Use of Radioactive Material are found in the Brown University Radiation Safety Manual, available online at http://www.brown.edu/Administration/EHS/restricted/rad_manual.pdf.

II. Record Keeping

Careful and thorough record keeping of all transactions involving radioisotopes is absolutely essential. It is required by law.

A Log Book containing the records of total activity of each isotope on hand, the results of monthly swipe tests, as well as a copy of our current License, Radiation Safety Bulletins, and Official Information is kept in Room 406. There is also a separate log book in which the amounts of individual radiochemicals are recorded, and a record kept of the use of each sample. Records are also kept of waste disposal; the appropriate entries are to be made on the Radioisotope Inventory Log Sheets, both by individual compound and for total isotope. In addition, a separate log is attached to each Radioactive Waste container. More detailed procedures are described below.

III. Ordering

Procedures for **Ordering, Receipt, and Unpacking of Radioactive Chemicals** are specified in the Brown University Radiation Safety Manual, available online at http://www.brown.edu/Administration/EHS/restricted/rad_manual.pdf.

IV. Laboratory-Specific Procedures for Receipt and Unpacking

1. All orders will be delivered unopened to the Chemistry Department Stockroom. You will be notified upon receipt.

2. All packages must be examined and opened in the fume-hood in Room 406.

3. Protective gloves must be used.

4. Ensure that you are familiar with the proper method for opening the container (eg. glass ampoule).

5. Check for cracks, or any other damage, to the container and for leakage of material.

6. Even though no visible evidence of a leak exists, take great care when handling the container.

7. For ^{3}H, ^{14}C, ^{32}P, or ^{35}S-labeled samples, wipe tests must be taken from the outside of the container and the results recorded in the log book.

8. For packages containing 10 mCi of ^{3}H, ^{14}C, ^{32}P or ^{35}S ("Type-A Quantities" – see Table 5, Radiation Safety Manual), a Geiger counter should be used to measure the level of radiation at the surface of the package; this measurement should agree with that on the packing list. Once the package has been opened, the radiation field of the unshielded container should be measured at the surface and at 3 feet and the values recorded on the packing slip and in the log book.

9. In the event of possible leakage or of any irregularity, contact Dr. Cane. Should contamination be detected on the outside of the container, notify the Radiation Safety Office.

9. Remember that the material may also present a chemical hazard as well as a radiation hazard, so take appropriate precautions.

10. Immediately after carrying out the above procedures, the receipt of the radiochemical must be recorded in **2** places:

    a) The total quantity of isotope received must be logged in on the Radioisotope Inventory Log Sheet and added to the total of isotope already on hand.

    b) New Radioisotope Inventory Log sheets must be added to the Radiochemical Log Book. The first sheet is the specification slip which accompanies each order and which describes the chemical, isotope, specific and total activity, and manufacturer's lot number. A second sheet should record the total isotope contained in the sample, the date received, and any relevant storage information. (For example, some samples may be dissolved in 5.0 mL of water and transferred to a plastic bottle. Subsequent

dispensing of portions of this material will be facilitated if a record is entered for activity/mL.)

V. Storage

1. Tritum, carbon-14, and sulfur-35 labeled materials are stored in the refrigerator in Room 406. Commerical samples are normally stored in the freezer section. F**or security, the refrigerator must be left locked. After storing or removing labeled compounds be sure to relock the refrigerator.**

Samples labeled with ^{32}P, an energetic β-emitter, must be stored in an acrylic block. **This container is to remain in the locked freezer in Rm 406 when not in use.**

2. All samples must be properly labeled. Commercial samples must specify the radiochemical, isotope, activity, and date received. Individual synthetic samples must bear the identity of the owner as well. Remember, condensation can wash away improperly prepared labels. Do not put anything in the refrigerator thinking you will remember tomorrow what it is. You probably will not, and neither will anyone else.

3. All samples must be in double containers to guard against contamination of the refrigerator and other samples due to leakage, breakage, spillage, etc. Special procedure: Use a *triple bag* to store samples of tritiated $NaBH_4$ (sodium borohydride) and tritiated water.

4. Each time you make a withdrawal from the stock of a commericial radiochemical, the transaction should be recorded in the Radiochemical Log Book. As stocks of radiochemicals are consumed or disposed of in other ways, the appropriate subtractions should be made in the Total Activity Log.

5. Special procedures are to be followed in handling and storage of tritiated water. Special precautions are taken for individuals handling more than 10 millicuries of tritiated water at one time. Skin surfaces will be monitored by swabs which will be monitored by liquid scintillation, and urine samples will be decolorized and counted by liquid scintillation. *The results of personal bioassays, both positive and negative must be entered into the Bioassay Log*. Bioassays should be carried out under the following conditions:

    1. Bioassays will be carried out whenever tritiated water is used in quantities greater than or equal to 10 mCi.

    2. Bioassays will be carried out whenever involatile tritiated substances or sodium [^3H]borohydride is used in quantities greater than or equal to 100 mCi. (N.B. special authorizaton would first have to be obtained from the Radiation Safety Office to acquire quantities of tritiated compounds in excess of our authorized laboratory limit for hydrogen-3 (tritium) of 50 mCi.)

Following the use of 10 millicuries or greater amounts of tritiated water, or 100 millicuries of organic compounds, the action level is considered to be five times the normal urinary radioactivity level in the liquid scintillation assay. In cases of positive results the individual will cease working with radioactive substances, and the Radiation Safety Office will be immediately notified for guidance and further action.

N.B. Tritiated water is volatile, it is normally highly active, it is readily inhaled, and it can contaminate everything in the lab if not handled sensibly. If you are careless with a sample containing 10^{12} dpm, it will be a long time before anybody else will be able to work with samples containing 10^{2} dpm.

VI. Handling

1. Radiochemicals are *radioactive chemicals*. All precautions appropriate to their *chemical* properties should be observed.

2. Pipetting by mouth is forbidden.

3. Handling or transfer of radioactive materials will be performed in trays lined with absorbent paper and covered with aluminum foil. At the end of each series of experiments you are responsible for disposing of the liners and replacing them with fresh material. The absence of contamination should be verified by a simple swipe test.

4. **For each experiment carried out in Room 406, you must attach a notice with your name, the date, and the isotope(s) being used. All glassware should be decontaminated and put away within 24 h of the completion of work. In no case should dirty glassware be allowed to accumulate in the Isotope Lab.**

5. The rotary evaporator in Room 406 must be used with your own splash guard. This simple precaution will keep the evaporator itself uncontaminated and prevent cross-contamination by someone else's samples.

5. In general, active samples or contaminated materials are to be confined to Room 406. Within Room 406, work with substantial activities should be confined, as much as possible, to the bench area between sink and hood and to the hood. The other work spaces in the room should be reserved for inactive materials, decontaminated glassware, etc. or minimal activity samples. Particular care should be taken in the vicinity of the Cahn Microbalance.

6. All contaminated glassware must be given final wash using an appropriate cleaning agent such as Counts-Off. The use of Chromerge is discouraged, as chromic acid baths are certainly more hazardous than any of the minor quantities of radiochemicals that you will routinely be dealing with.

7. Samples with total activity less than 10^6 dpm should be handled in the appropriate hoods in the individual laboratories authorized by the laboratory license, CHE-03 (Rooms 403, 404, 405, 407, 412, and 455). In working with weakly active samples this will avoid contamination by other materials in Room 406. In working with radioactive materials outside of Room 406, all normal safety, containment, and handling procedures mustld be followed. All reactions and chemical manipulations should be conducted in a hood, in accord with ordinary chemical safety and containment procedures. In addition a removable 'CAUTION - RADIOACTIVE MATERIAL' notice must be posted at the worksite (on the hood panel) listing the isotope being used and the person carrying out the experiment. All temporary use areas should be monitored by swipe tests at appropriate intervals and the absence of contamination verified upon completion of the experimental sequence. The results of these assays, including (and especially) *negative* results, must be recorded in the Log Book of Swipe Tests.

8. When working with ^{32}P-labeled samples, use appropriate shielding, such as a plexiglass or acrylic shield. A Geiger counter must be used to monitor the radiation level in the vicinity of the experiment, before, during, and after each experiment and the results should be recorded.

VII. Disposal

Guidelines for the disposal of radioactive waste can be found in the Waste Management Instructions on the Radiation Safety web site

1. Contaminated (radioactive) solid wastes, including contaminated glassware, paper towels, liners, aluminum foil, and empty scintillation vials, are to be discarded in the Radioactive Waste containers according to existing regulations and the maximum activity involved entered on the log sheet attached to the container. Uncontaminated solid waste, i.e. carrying no radioactivity above background - glassware, paper towels, liners, aluminum foil, empty scintillation vials, etc - can be disposed of as ordinary trash in closed plastic garbage bags.

2. Chromatographic materials and radioactive solid chemical wastes must also be disposed of in the waste containers provided by the Radiation Safety Office. Special care should be taken to avoid spreading contaminated silica gel around the lab both during and after disposal. (Wrapping in aluminum foil is helpful.)

3. Liquid waste samples are treated as radioactive waste:
   a) Tritiated water waste must be absorbed on an appropriate absorbent, capable of absorbing at least twice the quantity of liquid used (see Radiation Safety Manual 13.5) and the sealed and labeled containers placed in the Radioactive Waste container provided for this purpose. This is the preferred method for samples of tritiated water in excess of 50 mCi. For the latter type of samples, use of a double container, containing absorbent, is recommended.
   Under no circumstances should vials containing *any liquid* be placed directly in the

radioactive solid waste barrels.

b) Aqueous Liquid (for example, culture media, rinse water, and other low level waste that does not contain hazardous chemicals) can be sewer-disposed in concentrations below the limits specified in Section 15 of the Radiation Safety Manual. See the Waste Management Instructions on the Radiation Safety web site for detailed specifications. All sink disposals must be recorded. R. I. Law forbids disposal of any hazardous chemical waste down the sinks.

4. Liquid scintillation cocktails and vials.

a) Liquid scintillation cocktail (Optifluor) containing no measurable activity above background can be disposed of as ordinary chemical waste in the appropriate laboratory waste containers.

b) For liquid scintillation vials containing measurable activity less than 0.05 μCi/mL (10^5 dpm/mL): Do not pour the liquid from the liquid scintillation vials. Cap them tight and put them in the designated white pails with thick plastic liners. Keep a record of the activity in the bucket on the form RSO-15 as well as the identity of the cocktail used. These buckets will be collected by the Radiation Safety Office for proper disposal.

c) For liquid scintillation vials containing greater than 0.05 μCi/mL (10^5 dpm/mL): This situation would be highly unusual since the levels of activity would exceed the normal counting range of the liquid scintillation spectometer. Should such vials exist, do not pour the contents out. Place the vial in a separate bucket with appropriate labeling for disposal by the Radiation Safety Office.

5. Ultima-flo scintillation cocktail is used with the HPLC scintillation counter. The HPLC system has a cut off which is set to divert cocktail with more than 888 cpm to a radioactive waste container. This container should be properly labeled on the form RSO-15, indicating the identity and total volume of HPLC solvent and the total radioactivity in the container. When full, this container should be properly sealed and turned over to the Radiation Safety Office for proper disposal. Given the scale of most laboratory experiments it is highly unlikely that the final concentration will exceed 0.05 μCi/mL (10^5 dpm/mL).

The remaining HPLC effluent is disposed of as normal hazardous chemical waste.

6. Storage of waste containing ^{32}P (half-life 14.3 d) or ^{35}S (half-life ca. 88 d) until it has decayed to low levels (10 half-lives) is recommended, provided that the waste is properly shielded. Small volumes of ^{32}P can be stored in an acrylic box behind an acrylic shield in the hood in Room 406. Sulfur-35 waste is to be stored in labeled plastic bags or bottle under the radiation safety hood in Room 406. Any stored waste must be labeled to indicate the isotope, amount at time of storage, date of storage and your name. Alternatively, the Radiation Safety Office has space available for this purpose. Stored ^{32}P and ^{35}S waste must be checked with a Geiger Counter to verify that it is inactive before final disposal.

VIII. General Safety

1. Eating, drinking, smoking and the use of cosmetics in the laboratory are not permitted.

2. Before a worker leaves the laboratory the hands must be washed.

3. If, in the course of work, personal contamination is suspected, this should be reported to Dr. Cane immediately.

4. Gloves should be worn at all times when working with radioactive materials.

5. In the event of a spillage, the following procedures should be adopted:

   a. The liquid should be blotted up (wear rubber gloves).

   b. All disposable materials contaminated by the spill and the cleaning process should be placed in a container for radioactive waste.

   c. After cleaning up, the area of the spill must be monitored by swipe test. If necessary, cleaning should be repeated until swipe tests confirm complete absence of removable activity.

6. All wounds, spills, and other emergencies should be reported to Dr. Cane immediately.

7. Adequate protective clothing, appropriate to the level of activity being handled, should be worn.

8. **The door to Room 406 should be left locked when the laboratory is not in use. The last person to leave the laboratory in the evening should check to see that the door to Room 406 is locked.**

IX. Swipe Tests and BioAssays

1. The person responsible for the isotope lab will conduct monthly swipe tests in Room 406 and see that any contamination is cleaned up. Responsibility for swipe tests in other laboratories (See Section VI.7) rests with the individual carrying out experiments in those labs. The results must be recorded on the appropriate Swipe Test record sheet. In all cases, you are personally responsible for good housekeeping, including cleaning up after yourself.

2. To perform a swipe test, moisten a Kimwipe with water), wipe the area to be monitored (ca. 4 x 4 in; wear gloves) and put the Kimwipe in a scintillation vial containing 10 mL of scintillation cocktail. Close the vial, shake gently, and count. Swipe tests must be counted in duplicate to eliminate false readings that might result from chemiluminsecence . In the event that contamination above background is observed, the area should be cleaned and the

swipe test repeated until the affected area has been satisfactorily decontaminated. *All swipe tests should also include the counting of a standard.*

3. When working with ^{32}P, monitor yourself and your work area with a Geiger counter. The monitoring results must be recorded with the date each time ^{32}P is used. Before initiating work with ^{32}P, you must obtain an Exposure Monitoring Badge (Thermo Luminescent Devices) (both finger and body badges) from the Radiation Safety Office. These badges should be turned in to the Radiation Safety Office at the end of each quarter. In the event that you think you have been exposed to excess radiation, the badges should be turned in immediately.

4. When working with greater than 10 mCi of tritiated water or 100 mCi of other tritiated material, urine bioassays should be performed as described in Section V.5. above.