Appendix G.2

SAFE USE OF RADIOISOTOPES

INTRODUCTION

The Office of Environmental Health and Safety (EH&S) presents in this handbook recommendations for the safe use of radioisotopes. These procedures have been developed through laboratory surveys, experiment monitoring, project analysis, and investigations of contamination and exposure incidents. They follow the basic regulations found in the Radiation Safety Manual and precautions specified on individual Radiation Use Authorizations. Recommendations are of a general nature and may not apply to particular protocols. Contact EH&S for advice regarding a specific technique. General radioisotope use recommendations are discussed first, followed by hazards information about specific isotopes. Our experience has shown that there is considerable reduction in area contamination and personnel exposure when these basic precautions are employed.

GENERAL GUIDELINES FOR THE SAFE USE OF RADIOISOTOPES

The following are recommendations for the safe use of radioisotopes. These procedures have been developed through laboratory surveys, experiment monitoring, and investigations of contamination and exposure incidents. They are consistent with state regulations and standard radioactive materials license conditions. Recommendations are of a general nature and may not apply to all situations. Specific requirements of **your** RUA are found in the "Precautions Required" section of your RUA. The Radiation Safety Logbook also contains additional information on issues such as the packaging of radioactive wastes. Contact the EH&S or the Radiation Safety Officer (RSO) if you have questions.

General Bench Work

Locate radioisotope work areas away from heavy traffic and doorways. This reduces the severity of contamination spread should a spill occur. Clear an ample bench area of unnecessary items and cover it with an absorbent material with impervious backing, such as Kimpak. Tape the covering down and label it as a radioactive work area. Keep all equipment associated with the radioactive materials in this defined space. Label all radioisotope containers and contaminated equipment. Keep large volumes of radioactive liquid (that would not be contained by the bench covering) in trays or other secondary containers. If necessary, provide sufficient shielding to reduce radiation fields in the immediate vicinity of the material. Use proper containment for volatile or dispersible materials.

Containment

If volatile or dispersible radioactive materials (especially if high levels) are used there may be a potential for an airborne hazard from dust or vapor. Some containment may be required. Partial containment is offered by the use of chemical fume hoods and biological cabinets. Glove boxes and other specialized devices are available commercially. The EH&S can provide information about applicability and procurement of these devices. All systems to be used for radioisotope work requiring enclosures should be tested and approved before such use, and annually thereafter. The RUA will indicate if a fume hood is required for a certain procedure.

PREPERATION

Equipment

Assemble all items necessary for the procedure, so that delay during the experiment can be avoided. Do not leave hazardous operations unattended while additional equipment is located and prepared. Review the procedure and prepare a list of all materials that might possibly be required. A dry run may be advisable.

Emergency Supplies

Try and foresee what problems might occur, including spills, and store the appropriate materials that may be needed close to the work area. Some examples would be extra gloves and absorbent covering, wipes, paper towels, plastic bags, forceps, and decontamination solution. If a spill can be contained immediately, extensive contamination spread and personnel contamination are less likely.

Protective Clothing

Lab coats, gloves, closed-toe shoes, coverings for the legs, and appropriate eye protection are required for all handling of unsealed radioisotopes. Have enough gloves for frequent changes. Information on more specialized protective equipment is available from EH&S.

Dosimetry

When gamma or high-energy beta emitters are used, radiation dosimetry is usually required. Depending on the isotope and maximum amounts to be handled, TLD finger dosimeters and/or body badges will be assigned. Dosimeters must be worn whenever handling the material for which they are assigned. They must be stored away from radioactive materials and excessive heat and light when not in use. The RUA will indicate what, if any, dosimetry is required.

Instrumentation

Use of radioisotopes other than H-3 may require an appropriate radiation survey meter. Survey meter requirements are indicated on the RUA.

RADIOACTIVE WASTE

Place adequate waste receptacles (appropriately labeled) on the work surfaces so waste may be contained immediately after it is produced. For dry waste, a plastic bag in a can or Plexiglas box on the workbench is advised. This avoids transfers of contaminated items to the waste area during the procedure.

Liquid waste containers may also be kept on the bench in secondary containers. As appropriate, shield the waste receptacles for all isotopes except low energy beta emitters. Do not allow wastes to accumulate in the work area.

DRYRUNS

Before performing a new procedure with radioisotopes, it is sometimes helpful to make a dry run without any radioactivity, or at reduced levels. These runs should be identical to the proposed procedure. In some cases colored water may be added to stimulate the radioisotope. This will identify exactly which materials and methods are needed, and space and time requirements. Most likely routes of exposure or contamination may be identified and adjustments made to the procedure to reduce the hazard.

HANDLING PROCEDURES

Shipment Opening

Usually the highest activity is handled when the isotope stock bottle is opened. If the material is such that there is a possible build-up during shipment or storage, the container should be opened in an appropriate containment. A fume hood is a good site for opening packages. Always assume the outside of the primary container is contaminated and handle accordingly.

Direct manipulations

Much of the **inadvertent contamination** of laboratory surfaces is caused by **contact with contaminated work gloves**. Nearly all isotope work will involve some direct handling of open isotope containers. Whenever this occurs, assume the gloves are contaminated. Change them immediately if a “clean” item is to be handled. **Never wear the gloves away from the immediate work area after direct handling**, and check

them frequently with a survey meter (except for H-3). A dry run will show when gloves should be changed and preliminary assembly of all equipment will cut down on movement away from the work area to open drawers, refrigerators, etc.

Remote Manipulators

For isotopes presenting an exposure hazard some remote manipulation may be necessary. Use of tongs, forceps, pliers, etc., will lower radiation dose to the hands and reduce contamination spread. Metal implements should be rubber tipped for a more secure grip. Tools are likely to become contaminated and should be checked and cleaned after each use. Any equipment used should be properly labeled.

Transfers

When making liquid transfers do the work in a restricted area of the bench so as to avoid personnel and floor contamination from drips, spills, or splattering. For larger volumes of radioactive solution, a tray or tub should be used so all the liquid can be contained in case of spills. Use aids such as automatic pipettes and funnels. Cap solutions that are not to be used immediately. **Do not pipette radioactive material with any mouth-operated procedure**.

When moving an isotope solution away from the bench, secondary containment is necessary. Rigid, covered unbreakable carriers are needed if isotopes are to be transferred through public use areas (such as hallways).

SELF MONITORING

When working with isotopes other than H-3, it may be necessary to have a portable survey instrument on hand to monitor exposure levels and check for contamination. A thin-window Geiger-type survey meter is appropriate for work with beta emitters (including C-14 and S-35) and gamma emitters. I-125 monitoring requires use of an I-125 specific scintillation-type detector. The RUA may specify required self-monitoring and documentation requirements.

Monitoring with Survey Meters – With the exception of tritium, virtually all beta and gamma emitters can be “seen” with a GM detector survey instrument. This instrument can be used to determine the rough location and gross nature of contamination. The appropriate method is to position the probe surface 1 to 2 cm above the suspected surface and then slowly “paint” the area, listening to variation in the click rate. In general, to check for equipment of personnel contamination, the meter should be shielded from high background. Bench or floor surfaces should be checked directly and by wiping, then monitoring the wipe.

Wipe monitoring – This method can be used with all radioisotopes, and is the only reliable method for quantitative determination of contamination levels. Contamination levels are normally expressed as cpm/100 sq. cm of surface. The method involves wiping the surface with an absorbent medium (paper wipes) and then counting the wipes by LSC analysis. A background (uncontaminated) wipe is counted as a comparison control.

When using lower-energy beta emitters (H-3, C-14, S-35) surfaces should be checked with dry or damp pieces of filter paper or cotton swabs which are counted by liquid scintillation. Suggested areas to be examined: floor in front of work area, equipment (heaters, stirrers, tubing), and any items handled with work gloves during the experiment (faucet handles, drawer handles, pipetters). If extensive or high-level surface contamination (100 times background) is suspected, call EH&S.

Record Keeping – Documentation is maintained on self-surveys. The count data should be tied to a survey map by means of numbers or letters, so that areas found to be contaminated can be identified.

CLEAN UP

All items involved in the experiment must be surveyed, discarded, or cleaned and properly stored. Rinse reusable contaminated glassware twice (dispose into the liquid radioactive waste) before cleaning. Do not allow potentially contaminated items to accumulate in the work area or the sink.

Low-level surface contamination (bench or floor) may be cleaned in the following manner: rub alternately with a wet paper towel with cleaning solution, then a dry one. Start in least contaminated area and work to most contaminated. Discard the towels into the radioactive waste container after each application.

If possible, one sink should be designated and labeled for radioisotope clean-up purposes and all glassware and liquids that might be slightly contaminated should be placed there.

WASTE DISPOSAL

All contaminated or potentially contaminated material must be disposed of as radioactive waste.

Solid waste is placed in designated labeled containers. Place no liquid in the solid waste containers. Syringes and other sharp objects must be placed in appropriate infectious waste and sharps containers.

Liquid scintillation vials are disposed into designated containers.

Animal and biological tissues are normally segregated from other wastes, labeled, and kept frozen until packaging.

If waste is transported out of the laboratory it must be properly contained. Liquid waste bottles must be labeled, bagged, and carried in secondary containment. Solid wastes must be double bagged. All wastes must be documented as to date, Principal Investigator, and activity present.

Radioactive materials must be disposed CCR in accordance with the requirements of the CHORI radioactive material license and Title 17. Inappropriate disposal (such as to building trash) can result in **significant expenditure** to recover, regulatory action, potential criminal liability, and undesired publicity.

Once materials such as radioactive shipping containers have been emptied and surveyed to assure that they are not contaminated, deface or remove the radioactive labeling and markings. The containers may then be disposed or recycled as appropriate.

METALLIC LEAD

DO NOT dispose of contaminated lead as dry waste or place it in common trash. Lead must be decontaminated or allowed to decay and disposed of as a hazardous material or recycled.

DISPOSAL OF LIQUID SCINTILLATION COUNTERS

Some liquid scintillation counters contain an internal radioactive source. This radioactive source must be removed prior to disposing of the unit. Contact EH&S for advice on how to handle disposal.

STORAGE AND SECURITY

Radioactive storage containers and enclosures must be properly labeled. This includes cabinets, refrigerators, cold rooms, etc. Verify that all vessels are closed tightly and have secondary containment. Normally, refrigerators or other storage receptacles should be located in the laboratory. Do not store radioactive materials with or near food.

Many types of containers (such as plastic) are permeable to certain compounds, especially H-3 labeled materials. Such leakage has resulted in H-3 contaminated freezer ice. These compounds should be stored in rigid secondary containment such as metal.

Storage areas must be shielded so that there is less than 2 millirem per hour at contact with the container.

Laboratories with radioisotopes must be locked when unattended. Fire regulations require that lab doors be closed.

AIRBORNE HAZARDS CONTROL

It is required that proper functioning fume hood or equivalent approved enclosure be used whenever there is a possibility of airborne radioactivity.

To use the safety features of a fume hood effectively, the following procedures should be followed:

Never remove sashes or alter a hood. Always check to see if the hood is operating prior to use.

Remove all unnecessary items from the hood to prevent their contamination. Cover stationary objects not to be used.

Keep the materials in use away from sash openings to ensure containment.

Always wear a lab coat, gloves, and appropriate eye protection (further protection is available for arms and face). Never enter the sash opening without protection; avoid placing your head inside the plane of the hood opening.

Further protection can be achieved by working around a sash or shield and doing certain manipulations inside a plastic bag in the hood. Dry runs are advisable for unfamiliar procedures.

Keep volatile wastes in the hood. Close, mark and bag the container before removal.

EMERGENCIES

If there is any suspected personnel contamination, call EH&S immediately. Wash skin contamination with mild detergent. Do not use solvent or abrasives. If there is a radioisotope spill, contain by spreading absorbent material and limit access to through traffic in the vicinity of the spill. Contact EH&S immediately.

CONTAMINATION CONTROL

Proper use of equipment, techniques, and procedures can prevent personnel, equipment, and facilities from becoming contaminated. The following elements are the basis for a good contamination control program:

PERSONAL PROTECTIVE EQUIPMENT (PPE) – Used to prevent contamination of skin or clothing. PPE is required if there is a possibility of contamination.

Lab Coat – With sleeves long enough to cover the arms to the wrists, and long enough to cover the torso to the thighs. Wear with the closures fastened.

Eye Protection – Worn to protect the eyes from splashes of radioactive and other hazardous materials.

Closed-toe Shoes, Long Pants or Long Dresses – Worn to protect the feet and legs from splashes.

Disposable Gloves – Worn to protect the skin of the hands and wrists from contamination. Most effective if two pairs are worn at a time, with the outer pair changed frequently.

APPROPRIATE BENCH COVERINGS – Used to prevent contamination of bench and hood surfaces.

Plastic Backed Disposable Paper – Taped in place with the plastic side down. These coverings are replaced whenever damaged (worn, soiled or torn) or contaminated.

Containment Trays – These shallow trays are useful for certain work situations. They are available with disposable plastic liners to ensure ease of decontamination.

DOUBLE CONTAINMENT METHODS – The use of secondary containers of sufficient volume to contain all of the liquid should a spill occur.

Liquid Waste Storage Cans – Used to store liquid radwaste bottles.

Transport Containers – Usually a deep plastic tray with a snap fitting lid, these are used to double contain radioactive material being transported between laboratories.

USE OF DISPOSABLES – whenever feasible, it is preferable to use disposable plastic pipette tips, petri dishes, centrifuge tubes, etc. this prevents the need for decontamination of glassware.

APPROPRIATE HANDLING TOOLS – these serve dual purposes, reducing hand contamination while reducing extremity dose (includes tweezers, forceps, tongs and shielded containers).

MARKING AND LABELING – this is the single most important contamination control measure. ALL RADIOACTIVE USE AREAS, EQUIPMENT AND STORAGE CONTAINERS MUST BE MARKED WITH THE RADIATION WARNING SYMBOL.