Safety Precautions when Using Specific Types of Isotopes

The appropriate safety measures one should follow depend on the characteristics of a particular nuclide. The following paragraphs summarize safety precautions you should follow when working with radio-nuclides of similar type and energy.

LOW ENERGY BETA EMITTERS

Radionuclide	Half-Life	Energy (Emax) in kev	Max. range in air (inches)
Hydrogen-3	12.3 yrs	18.6	0.19
Nickel-63	100 yrs	66.0	2.00
Carbon-14	5730 yrs	156.0	8.60
Sulfur-35	87.4 days	167.0	9.60
Calcium-45	165 days	252.0	19.00

Millicurie quantities of low energy beta emitters do not present an external exposure hazard since they cannot penetrate the outer dead layer of skin. However, extreme caution should be taken to avoid internal contamination. These nuclides will have an affinity for certain target organs and can impart a significant local dose to that portion of the body.

The energy of the beta particles emitted by hydrogen-3 is so low that they can't be detected with a GM survey instrument. Therefore, special care is needed to maintain a clean work area. Regular monitoring by wipe testing is advisable. Wipes should be counted on a liquid scintillation counter. When working with large amounts of hydrogen-3 (>100 millicuries), bioassays must be submitted to the Radiation Safety Office.

All other low energy beta emitters can be detected with a **thin window GM probe**. Surveys of work areas should be performed after each series of experiments. In addition, weekly wipe tests of the work areas must be performed.

No shielding of low energy beta emitters is required. Personnel dosimeters are of no use with these radio-nuclides as they are not capable of detecting low energy emissions.

HIGH ENERGY BETA EMITTERS

Radionuclide	Half Life	Energy (Emax)	Max. range in air
Phosphorus-32	14.3 days	1.7 Mev	20 feet
Rubidium-86	18.7 days	1.8 Mev	21 feet

High energy beta emitters are considered an external as well as an internal hazard. They are intermediate in their penetrating power between the low energy beta emitters and the gamma emitters. They can penetrate to the deep layers of skin or the subcutaneous region depositing a significant amount of energy there and imparting a significant dose to the region. Exposure to the eye surface should be kept to a minimum as continued exposure to the eyes over a long period of time can lead to cataracts.

A radiation dosimeter must be worn when working with high energy beta emitters. A whole body badge and a ring badge must be worn.

Shielding of high energy beta emitters is a necessity. The shielding should consist of low density material such as Plexiglas to reduce the amount of bremsstrahlung x-ray formation. If 10 millicuries or more of a radionuclide are used in an experiment, a thin sheet of lead should be placed on the back side of the Plexiglas to absorb the x-rays. (Note: never place the lead in front of the Plexiglas).

Work areas should be monitored with a GM survey meter during and after an experiment. Wipe tests of the work areas must be performed on a weekly basis.

LOW ENERGY GAMMA EMITTERS

Radionuclide	Half Life	Energy (kev)	Exp. rate of 1 mCi at 1 cm
Iodine-125	60.0 days	35 kev	1.40 R/hr
Xenon-133	5.25 days	81 kev	0.51 R/hr

Low energy gamma emitters should be shielded with a high density material such as lead. A thin sheet of lead is usually sufficient. Both iodine and xenon are airborne hazards. Extreme caution should be taken to avoid inhalation. All work done with elemental iodine (not tagged iodine) should be performed in a fume hood with a capture velocity of 125-150 linear feet per minute. Solutions containing iodine ions should not be made acidic or stored frozen as both can lead to the formation of volatile elemental iodine. Two pairs of rubber gloves must be worn as iodine compounds can penetrate surgical rubber gloves.

A radiation dosimeter (whole body badges) must be worn.

When working with millicurie quantities of elemental iodine, you must monitor your thyroid for the presence of the radioiodine. Contact the Radiation Safety Office for specific details.

Monitoring of work areas must be performed using a GM survey meter.
Weekly wipe tests must be performed in all work areas.

MEDIUM ENERGY GAMMA EMITTERS

Radionuclide	Half Life	Energy (kev)	Exp. rate of 1 mCi at 1 cm
Cobalt -57	271 days	136	0.94 R/hr
Thallium-201	73 days	167	0.44 R/hr
Tc-99m	6 hrs	141	0.77 R/hr
Gallium-67	78 hrs	300	0.75 R/hr
Chromium-5	28 days	320	0.18 R/hr
Iodine-131	8 days	360	2.16 R/hr

The same precautions must be observed for medium energy gamma emitters that were mentioned for low energy gamma emitters. Additional shielding may be required.

HIGH ENERGY GAMMA EMITTERS

Radionuclide	Half Life	Energy (kev)	Exp. rate of 1 mCi at 1 cm
Molybdenum-99	66 hrs	740	1.66 R/hr
Iron-59	44 days	1,290	6.18 R/hr
Sodium-22	2.6 years	1,280	11.80 R/hr

Additional shielding will be required when working with high energy gamma emitters. Remote handling tools should be considered. Monitor with a GM survey meter. Radiation dosimeters are required.