RADIATION SAFETY DATA – ^{14}C

^{14}C is widely used in life sciences research. A wide range of ^{14}C-labeled compounds are available, but only rather low specific activities are attainable; forms with uniform labeling or selective parts of the molecule labeled are often available. The very long half-life means that isotope levels do not change significantly over decades. The low beta energy emission makes ^{14}C safe to handle (unless volatile), yet permits some detection with a hand-held monitor and very efficient detection by liquid scintillation counting.

Physical Data

Decay mode	beta emission to ^{14}N (stable)
Physical half-life	5730 years
Major emissions	beta minus, 155 keV max, 49.4 keV avg
Range in air	23.2 cm
Range in water/tissue	about 0.3 mm

Biological Data

Dose to live skin	Minimal external hazard, since beta particles barely penetrate the outer dead skin layer
Other doses	Most ^{14}C-labeled radiochemicals become widely distributed in the body after intake and metabolism. Average doses for most organics, include CO and CO_2, are estimated at 2-2.5 mrem/μCi intake for adults.
Annual limit on intake	ingestion - 2 mCi inhalation - monoxide 200 mCi - dioxide 20 mCi - compounds 2 mCi

The critical organ for ^{14}C uptake is the whole body; most organic compounds are metabolized and become widely distributed and transformed into other compounds. The general biological half-life is about 40 days. Release of $^{14}CO_2$ gas can occur in many instances.

The generally low specific activities encountered minimize exposure hazards.

Common Hazards – Precautions

Detection of contamination is difficult using portable survey instruments, and necessitates the use of swipes counted by liquid scintillation. Liquid scintillation counting efficiency approaches 95%. Typical efficiency for a pancake GM probe at ½" is ~2-3%.

A special problem associated with ^{14}C use is that many compounds are metabolized to release $^{14}CO_2$. Bicarbonate, especially, which is frequently used for biomass productivity studies, readily releases CO_2 on acidification. All such applications resulting in gaseous ^{14}C must be

carried out with adequate venting. Released CO_2 can be trapped with highly alkaline solutions, but liquids with pH > 12.5 cannot be disposed as general liquid radioactive waste.

No shielding is required during ^{14}C use.

Specific Requirements for Handling at OSU

No film or finger badges are required due to minimal external hazard. Survey meters are required when handling > 10 μCi amounts.

Liquid waste must be stored in appropriate containers with properly fitting screw caps supplied by the Radiation Safety Office, and these containers must be inside a secondary container capable of holding the entire fluid in the event of bottle rupture. Volatile compounds must be stored in a fume hood and vented extensively before disposal. Dry solid waste should be held in the provided 15-gallon drums. Drain disposal is not permitted; the second rinse of a container is considered to be free of ^{14}C.

For ^{14}C-labeled compounds that are classified toxic or carcinogenic, including organic solvents, care must be taken to segregate waste and declare it as mixed waste.

The Oregon State limit for ^{14}C release in a fume hood is 2×10^{-6} μCi/ml (5.66×10^{-2} μCi/ft^3) for monoxides, 3×10^{-7} μCi/ml (8.495×10^{-3} μCi/ft^3) for dioxides, and 3×10^{-9} μCi/ml (8.495×10^{-5} μCi/ft^3) for compounds. A 3 foot fume hood drawing 100 linear feet/minute with the sash at 15" draws 375 ft^3/minute. Use these figures to estimate volatile release when preparing Radiation Use Authorization applications.