RADIATION SAFETY DATA – ^{3}H

Tritium (^{3}H) is widely used in life sciences research. A wide range of tritium-labeled compounds are available, at moderate specific activity, and forms with uniform labeling or selective parts of the molecule labeled are often available. The moderate half-life permits the use of chemically stable isotope batches over a period of years. The very low beta energy emission limits some applications and makes the detection of spills more difficult, but is an advantage in cytological localization studies. The very low beta energy results in no external hazard, but internal health hazards are significant if taken into the body.

Physical Data

Decay mode	beta emission to ^{3}He (stable)
Physical half-life	12.4 years
Major emissions	beta minus, 19 keV max, 5.68 keV avg
Range in air	5 mm
Range in water/tissue	about 6 μm

Biological Data

Dose to live skin	Nil unless contact results in uptake into cells; no external hazard
Other doses	Most tritiated radiochemicals become widely distributed in the body after intake and metabolism. Average doses are estimated at 0.063 mrem/μCi intake for adults. Doses to nuclear DNA are greater when ^{3}H(thymidine) is involved.
Annual limit on intake	Ingestion - 80 mCi Inhalation – 80 mCi

The critical organ for tritium uptake is the whole body water, since most compounds can be metabolized to some extent, some extensively. Tritium at many sites in molecules can be exchanged with aqueous media as protons, further resulting in wide dissemination in the body. Tritiated water and readily metabolizable forms are eliminated with a 10-day biological half-life. Elimination rates can be increased by increasing water intake.

Some special cases exist, notably tritiated thymidine, which can result in higher doses to the cell nucleus due to its specific incorporation into DNA. Since DNA has low turnover, tritium residence time is longer, resulting in damage to the genetic material.

Common hazards – Precautions

A major problem with tritium is the difficulty of detection and measurement of uncontained radiomaterial. Portable survey instruments are unable to detect the low-energy beta spectrum, so contamination must be detected by counting swipes by liquid scintillation or in a windowless gas-flow counter. Liquid scintillation counting efficiency approaches 60%.

Contamination with tritium can be harder to avoid compared with other isotopes.

A) At some sites in molecules (electron-deficient sites that permit exchange of acidic protons with the solvent), tritium can become equilibrated with the aqueous solvent, resulting in the generation of volatile tritium from non-volatile labeled compounds. Thus, gaseous release must always be considered.
B) Some compounds can release tritium gas on acidification or heating; sodium Borotritide and other hydrides used in organic syntheses are common examples. Work with such compounds must be in a properly functioning fume hood.
C) Under some conditions – when handling > 10 mCi of compounds with readily exchangeable protons – tritium compounds can penetrate gloves, move through plastic containers, across lab bench covering, migrate out of vials along screwcap threads, etc. This presumably occurs by movement of tritiated water vapor or condensate after exchange with environmental water. Refrigerators used for storage can become contaminated by tritium movement out of containers. Storage areas holding >10 mCi should be monitored for contamination routinely; one less obvious technique is to sample ice or frost for liquid scintillation counting.
D) Vacuum systems used in handling high activity tritiated materials often become contaminated internally. Pump exhausts should be properly vented, and oil monitored before disposal or pump repair.

No shielding is required during tritium use.

Some older style electron capture detectors coupled to gas chromatographs contain very large amounts (0.25-1 Ci) of titanium or scandium tritide. To prevent release of tritium and ruin of the sources, maximum temperatures are limited to 225^{o}C for titanium tritide and 325^{o}C for scandium tritide. Such gas chromatographs must be fitted with automatic temperature limiting devices and must be properly vented.

Specific requirements for Handling at OSU

No film badge or finger badges are required due to zero external hazard. Survey meters are not required and not useful.

Liquid waste must be stored in appropriate containers with properly fitting screwcaps 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 ^{3}H.

For tritiated 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 tritium release in a fume hood is 1×10^{-7} μCi/ml (2.83×10^{-3} μCi/ft ^{3}). 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.