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Safety Information

and Specific Handing

Precautions for Radionuclides

H-3, C-14, S-35

P-32 and I-125

Tritium (H-3) Safety Information and Specific Handling Precautions

General:

Tritium is a very low energy beta emitter and even large amounts of this isotope pose no external dose hazard to persons exposed. The beta radiation cannot penetrate the outer protective dead layer of the skin of the body. The major concern for individuals working with this isotope is the possibility of an internal exposure. Such an exposure may occur if an individual contaminates bare skin, accidentally ingests the material, or breathes it in the form of a gas or vapor. The critical organ for a tritium uptake is the water of the whole body. Three to four hours after an intake of tritiated water, the radioactive material is uniformly distributed throughout the body fluids. A tritium intake may be easily detected by analyzing a urine sample.

Many tritium compounds readily migrate through gloves and skin. Data from accidents involving tritium indicate that 80% of the body exposure occurs through skin absorption. Tritium compounds should be handled with gloved hands, and in some cases, with double gloves. Change gloves often. Tritiated DNA precursors are considered more toxic than tritiated water. However, they are generally less volatile and do not normally present a significantly greater hazard.

Physical Data:

Maximum beta energy: 0.019 MeV, 100% emission.

Maximum range in air: About 1/6 of an inch

Radiological Half-life: 12.28 years.

Internal Occupational Limits:

Annual Limits on Intake-

Inhalation: 80 mCi

Ingestion: 80 mCi

Precautions:

1. Follow General Safety Precautions for all isotopes.
2. Monitor surfaces routinely and keep record of the results. Geiger counters (survey meters) are not sensitive to tritium radiation and therefore wipe tests and a liquid scintillation counter are necessary to determine levels of contamination. Radiation badges are not issued to individuals using only tritium because the radiation emitted by tritium is not of sufficient strength to penetrate the badge.
3. Submit urine samples for analysis if requested to do so by the Radiation Safety. MCG's current GDNR license requires an individual to submit a urine sample when working with 100 mCi or more of tritium at one time.
4. Due to the long half-life of tritium, tritiated waste must be segregated from short-lived waste. H-3 and C-14 waste may be combined, but must be kept separate from P-32, S-35, I-125 and other radioactive waste.

Carbon-14 (C-14) Safety Information and Specific Handling Precautions

General:

Carbon-14 is a low energy beta emitter and even large amounts of this isotope pose little external dose hazard to persons exposed. The beta radiation barely penetrates the outer protective dead layer of the skin of the body. The major concern for individuals working with this isotope is the possibility of an internal exposure. Such an exposure may occur if an individual contaminates bare skin, accidentally ingests the material, or breathes it in the form of a gas or vapor (usually radioactive CO2). The critical organ for most C-14 labeled compounds is the fat of the whole body. The most hazardous chemical form of C-14 is labeled carbonates for which the bone is a critical organ. Ingested carbon is metabolized very quickly and much of the radionuclide is exhaled in the form of radioactive carbon dioxide. Urine analysis is an effective sampling technique to determine if a C-14 uptake has occurred.

Some C-14 labeled compounds may migrate through gloves and skin. C-14 compounds should be handled with gloved hands, and in some cases, with double gloves. Change gloves often. One should be careful not to contaminate the skin as some C-14 beta particles penetrate the dead layer of the epidermis. Special caution should be taken when handling C-14 labeled halogenated acids. These compounds may be incorporated in the skin, causing very large skin doses and a pathway into the body.

Physical Data:

Maximum beta energy: 0.156 MeV, 100% emission

Maximum range in air: about 8.6 inches

Radiological Half-life: 5730 years

Internal Occupational Limits:

Annual Limits on Intake-Inhalation: 2 mCi

Ingestion: 2 mCi

Precautions:

1. Follow General Safety Precautions for all isotopes.
2. Monitor surfaces routinely and keep records of the results. Geiger counters are sensitive to the beta radiation from C-14 if the probe is used within a 1/2 inch of the surface and the proper probe is used. Radiation Safety recommends a pancake type probe and a meter with a linear scale. With such a probe very low amounts of C-14 may be detected on a surface. Average efficiency with a pancake probe is approximately 3%. Do not cover the pancake probe with saran wrap® or parafilm®, etc. when using the probe to monitor for C-14. This practice will decrease the efficiency of detection. Wipe tests should be taken and counted in a liquid scintillation counter for the most sensitivity when detecting removable surface contamination.

Phosphorus-32 (P-32) Safety Information and Specific Handling Precautions

General:

Phosphorus-32 is an energetic beta emitter which can penetrate up to 0.8 cm into living skin tissue. Therefore, this isotope poses an external (skin) dose hazard to persons as well as a potential internal hazard. An internal exposure may occur if an individual contaminates bare skin, accidentally ingests the material, splashes it into the eyes, or breathes it in the form of a gas or vapor. The bone is the critical organ for intake of P-32 transportable compounds. Although about 60% of ingested Phosphorus-32 is excreted within the first 24 hours, only 1% per day is excreted after the second or third day following ingestion. Dose evaluations will require knowledge of the approximate date and time of exposure to the isotope. The external hazard of P-32 can be reduced by applying the principles of time, distance and shielding. The dose rate at the open combi-vial top containing 1 mCi of P-32 in 1 ml of liquid is roughly 26 rem/hour! Since this dose rate will not be attenuated significantly by air, shielding materials should be placed between the source and personnel to absorb most of the radiation.

Never work over an unshielded open container of P-32. The best shield for a P-32 source is a material like lucite or plexiglass (about 1/2 inch thick), which will absorb the beta particles while generating little secondary radiation (Bremsstrahlung). The less time spent near a radiation source of P-32, the lower the exposure.

A high local skin dose can be received if the radioactive material is touched and allowed to remain on the skin or gloves. An amount of 1 uCi of P-32 deposited in 1 cm 2 area of bare skin would exceed the NRC annual skin exposure limit in less than eight hours. The face, eyes and hands can receive considerable exposure from an open container of P-32, particularly if the radioactivity is in a concentrated form. The eye itself may receive a high local dose as well as providing a pathway into the body. The eyes should be protected from P-32 by wearing safety glasses. Safety goggles will prevent splashes from getting into the eyes and will also act as shielding for the eyes. The distance between yourself and a P-32 source can be easily increased by using remote handling devices such as tongs or forceps. This safe handling technique of using distance can substantially reduce exposure from P-32.

Physical Data:

Maximum beta energy:1.71 MeV, 100% emission.
Maximum range in air: 18 to 20 feet.
Radiological half-life: 14.29 days.
Internal Occupational Limits:
Annual Limits on Intake-
Inhalation: 0.9 mCi
Ingestion: 0.6 mCi

Precautions:

1. Follow General Safety Precautions for all isotopes.
2. Perform dry runs and practice routine operations to improve dexterity and speed before using P-32.
3. Avoid skin exposure by using tools to indirectly handle unshielded sources and potentially contaminated vessels.
4. Traps may be necessary to collect 32 P if large gas or vapor releases are anticipated. This is to reduce the release to the environment.
5. Monitor surfaces routinely and keep records of the results. Geiger counters with a pancake probe should be used for P-32 radiation. Average efficiency for detecting P-32 with a pancake probe is 30%. Use wipe tests and a Liquid Scintillation Counter to determine levels of removable P-32 contamination.
6. Do not work over open containers of P-32 without shielding. Work with plexi-glass shields (1/4 to 1/2 inch thickness). Shield all stock vials of P-32. Do not use thin sheets of lead to shield P-32.

Sulphur-35 (S-35) Safety Information and Specific Handling Precautions

General:

Sulfur-35 is a low energy beta emitter and even large amounts of this isotope pose no external dose hazard to persons exposed. The beta radiation barely penetrates the outer protective dead layer of the skin of the body. The major concern for individuals working with this isotope is the possibility of an internal exposure. Such an exposure may occur if an individual contaminates bare skin, accidentally ingests the material, or breathes it in the form of a gas or vapor. The critical organ for most S-35 labeled compounds is the whole body. Urine analysis is an effective sampling technique to determine if a S-35 uptake has occurred.

Some S-35 labeled compounds may migrate through gloves and skin. S-35 compounds should be handled with gloved hands, and in some cases, with double gloves. Change gloves often. One should be careful not to contaminate the skin as some S-35 beta particles penetrate the dead layer of the epidermis. Some S-35 compounds may be incorporated in the skin causing very large skin doses and a pathway into the body. Certain forms of S-35 (methionine, and cysteine) are volatile. Use a hooded enclosure, when possible, while handling volatile forms of S-35. Activated charcoal is effective in helping to trap volatile species.

Physical Data:

Maximum beta energy: 0.167 MeV, 100% emission

Maximum range in air: about 9.6 inches

Radiological half-life: 87.4 days

Internal Occupational Limits:

Annual Limit on Intake-Inhalation: 20 mCi

Ingestion: 8 mCi.

Precautions:

1. Follow General Safety Precautions for all isotopes.
2. Traps may be necessary if large gas or vapor releases are anticipated. This is to reduce the release to the environment. It may be necessary to incorporate activated charcoal into experiments involving volatile forms of S-35.
3. Monitor surfaces routinely and keep record of the results. Geiger counters are sensitive to the beta radiation from S-35 if the probe is used within a 1/2 inch of the surface and the proper probe is used. The Radiation Safety Section recommends a pancake type probe and a meter with a linear scale. With such a probe very low amounts of S-35 may be detected on the surface. Average efficiency for S-35 with a pancake probe is approximately 8%. Do not cover the pancake probe with saran wrap® or parafilm®, etc. when using the probe to monitor for S-35. This practice will decrease the efficiency of detection. Wipe tests should be taken and counted in a Liquid Scintillation Counter for the most sensitivity when detecting removable surface contamination.
4. Proper tubes should be used for storage of single use aliquots of volatile S-35 material. Screw top tubes with rubber seals are recommended.

Iodine-125 (I-125) Safety Information and Specific Handling Precautions

General:

Iodine125 (I-125) safety information and specific handling precautions General: I-125 is considered toxic because of its affinity for the thyroid gland. Accordingly, allowable air and water concentrations are extremely low, making it extremely important that the release of radioiodine in the laboratory be controlled. Unbound radioiodine is extremely volatile and must be handled appropriately. Radioiodine is biologically active, and up to 30% of any activity ingested may concentrate in the thyroid gland. The maximum permissible levels of contamination in non-ventilated areas are well below the detection limit for a typical Geiger counter. Therefore, a thin crystal sodium iodide detector is recommended. Average efficiency for detecting 125 I with a sodium iodide probe is approximately 30%. 125 I decays with a half-life of 60 days. It emits soft gamma radiation and x-rays with a maximum energy of about 35 KeV; also emitted are conversion and auger electrons with a maximum energy of about 35 KeV. Radioiodine metabolized by the thyroid gland has an effective half-life in the thyroid gland of about six weeks.

Physical Data:

Maximum gamma radiation energy: 35 KeV
Maximum range in air: N/A
Radiological half-life: 60 days
Annual Limits on Intake:
Inhalation: 0.06 mCi
Ingestion: 0.04 mC

Precautions

1. Follow General Safety Precautions for all isotopes.
2. Use forceps fitted with rubber sleeves to ensure a secure grip on containers.
3. Radiation badges should be worn by all personnel involved in performing iodinations.
4. Radiation Safety approved hoods must always be used when performing iodinations.
5. Never remove the rubber vial septum on containers of volatile iodine! Remove all NaI-125 aliquots with hypodermic syringes inserted through the vial's rubber septum.
6. If the iodination procedure requires a vacuum withdrawal of supernate or other substance containing iodine, an iodine trap should be placed between the collection flask and the vacuum source in order to protect the house vacuum line from contamination.
7. Store NaI-125 solutions at room temperature in an approved hood, do not freeze and avoid heating Na I-125 as this

   will result in subsequent volatilization.
8. Maintain a pH greater than 7 in NaI-125 solutions in order to reduce volatilization.
9. Have reducing agents available when using NaI-125.
10. In the event of a spill involving volatile NaI-125 hold your breath and vacate the iodination area closing the doors behind you. Do not permit anyone to enter the spill area and contact Radiation Safety immediately.
11. More information pertaining to thyroid counts may be obtained by calling Radiation Safety.