

Occupational Safety & Environmental Health
Radiation Safety Service
1239 Kipke Drive 1010
[764-4420]

HYDROGEN - 3
[H-3]

PHYSICAL DATA

Beta Energy: 18.6 keV (maximum)
5.7 keV (average) (100%)

Physical Half-Life: 12.3 years
Biological Half-Life: 10 - 12 days
Effective Half-Life: 10 - 12 days *

* Forcing liquids to tolerance (3-4 liters/day) will reduce the effective half-life of H-3 by a factor of 2 or 3.
(Relatively easy to flush out of system with fluids).

Specific Activity: 9650 curies / gram

Maximum Beta Range in Air: 5 mm = 0.5 cm = 1/4"

Maximum Beta Range in Water: 0.005 mm = 0.0005 cm = 3/10,000"

Penetrability of Beta Particle in Matter or Tissue: Insignificant *

* [0% of beta particle energy transmitted through dead layer of skin]

RADIOLOGICAL DATA (H-3)

- Least radiohazardous of all radionuclides
- Critical Organ: Body Water or Tissue
- Routes of Intake: Ingestion, Inhalation, Puncture, Wound, Skin Contamination (Absorption)
- External exposure from weak H-3 beta energy - not a concern
- Internal exposure & contamination are primary radiological concerns

• Committed Dose Equivalent (CDE): 64 mrem / mCi
(inhalation, ingestion, or puncture)

• Committed Effective Dose Equivalent (CEDE): 64 mrem / mCi
(inhalation and ingestion)

• Annual Limit on Intake (ALI): 80 mCi (ingestion or inhalation) [H₃O]

* [1.0 ALI = 80 mCi (H-3) ingested or inhaled = 5,000 mrem CEDE]

- Skin Contamination Exposure Rate: 57,900 mrad/h per 1.0 mCi (contact)
 - * Exposure rate to 'dead layer of skin' (<0.007 cm depth) only.
 - * Skin contamination of $1.0 \text{ uCi/cm}^2 = 0 \text{ mrad/h}$ dose rate to basal cells
- Rule of Thumb: 0.001 uCi/liter of H-3 in urine sample is indicative of a total integrated whole body dose of approximately 10 millirem (average person) if no treatment is instituted (flush with fluids) [NCRP-65 / 1980]

SHIELDING: none required

SURVEY INSTRUMENTATION:

- H-3 **CANNOT** be detected using a G-M or NaI survey meter
- Use Liquid scintillation counter (indirect) only to detect H-3 contamination on smears or swipes [LSC counting efficiency (max): 50% (full window)]

PERSONAL RADIATION MONITORING DOSIMETERS (Whole Body Badge or Finger Rings): Not Needed (H-3 beta energy is too weak)

RADIOACTIVE WASTE: solid, liquids, scintillation vials, pathological materials (combine with C-14 contaminated objects only)

REGULATORY COMPLIANCE INFORMATION (10 CFR 20 / Appendix B)

- Derived Air Concentration (DAC): $2.0\text{E-}5 \text{ uCi/cc}$ (occupational)
- Airborne Effluent Release Limit: $1.0\text{E-}7 \text{ uCi/cc}$ *
[Annual Average]
 - * [Applicable to the assessment & control of dose to the public (10 CFR 20.1302). If this concentration were inhaled continuously for over a one-year period the resulting TEDE would be 50 millirem.]
- Unrestricted Area Removable Contamination Limit: $1,000 \text{ dpm/100 cm}^2$
- Posting Areas or Rooms [10 CFR 20.1902(e)]: $>10,000 \text{ uCi}$
- Container Labeling Quantity [10 CFR 20.1905]: $\geq 1,000 \text{ uCi}$
- Exempt Quantity [10 CFR 30.18] $1,000 \text{ uCi}$
- Limited Quantity [DOT / 49 CFR 173.425]: $\leq 108 \text{ mCi}$

- Type A Quantity [DOT / 49 CFR 173.425]: > 108 mCi
* [Requires Type A Container]
- Reportable Quantity ["RQ" / 49 CFR 172.101]: 100 Ci
- Urinalysis: license **REQUIREMENT** when handling \geq 100 mCi H-3

GENERAL RADIOLOGICAL SAFETY INFORMATION (H-3)

- Inherent Volatility (at STP): SUBSTANTIAL
- Experimental uses include total body water measurements & in-vivo labeling of proliferatory cells by injection of tritium-labeled compounds (ie: thymidine). Tritium labeling is also used in a variety of metabolic studies.
- Oxidation of H-3 gas in air is usually slow (< 1% per day)
- Absorption of H-3 inhaled in air is much less when it is present as elemental H-3 than as tritiated water (HTO).
- Tritium penetrates the skin, lungs, and GI tract either as tritiated water or in the gaseous form.
- As gaseous hydrogen, H-3 is not significantly absorbed into the body and does NOT exchange significantly with hydrogen in the body compounds.
- As water (HTO), the H-3 entering the lung or GI tract is completely absorbed and is rapidly dispersed throughout the body.
- Some H-3 is incorporated into cellular components and has a long turnover rate.
- Forcing fluid reduces internal exposures from H-3.
- Monitor for H-3 contamination using only smears, swabs, swipes, or wipe testing (bench tops, floors, refrigerator/freezer handles, phone, etc).
- **Always** wear a lab coat & disposable gloves when handling H-3.
- Skin contamination, ingestion, inhalation, and punctures involving H-3 are primary radiological concerns (internal doses).
- Tritiated water, taken into the body by inhalation, ingestion, or absorption through the skin is assumed to be completely and instantaneously absorbed and rapidly mixed with total body water.
- The volume of total body water (standard man) is 42,000 ml.
- The concentration of H-3 (uCi/ml) in urine is assumed to be the same as that in total body water. [urine concentration = body concentration]

- Detection Limit of H-3 in Urine: 1.08E-5 uCi/ml (approximately).
- For a continuous inhalation exposure at a rate of 1/365 of an ALI per day, the equilibrium concentration of H-3 in urine is 0.073 uCi/ml. [NOTE: 1/365 of 80 mCi (ALI) = 219 uCi]
- The predicted concentration activity normalized to unit intake from inhalation is 2.204E-5 uCi/ml per uCi of H-3 intake.
- Tritiated thymidine, if not catabolized, is taken up only by the nuclei of those cells synthesizing DNA.
- The ingestion ALI of tritiated thymidine is likely to be approximately 1/10 of that for tritiated water.
- The ALI for tritiated thymidine might be as much as 50-times smaller than the ALI for tritiated water.
- Ingested tritiated water is assumed to be completely and instantaneously absorbed from the GI tract and to mix rapidly with the total body water so that, at all times following ingestion, the concentration in sweat, urine, sputum, blood, insensible perspiration, and expired water vapor is the same.
- Tritiated water is instantaneously distributed uniformly among all the soft tissues of the body after inhalation.
- Organic compounds of H-3 are not very volatile under normal circumstances and the probability of their being inhaled as vapors is, therefore, small.
- Beta dose rates from 1.0 millicurie H-3 point source:

<u>Rad/h</u>	<u>Distance</u>
10,293.00	0.25 cm
28.12	0.50 cm
1.12	0.56 cm

TRAINH3

ORIGINAL: MARCH 1994 (MLD)
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