

Occupational Safety & Environmental Health

Radiation Safety Service

1239 Kipke Drive 1010

[(313) 764-4420]

TECHNETIUM - 99m

[Tc-99m]

PHYSICAL DATA

Gamma Energies: 140.51 keV (89.1% abundance)
18.37 keV (4.0%)
18.25 keV (2.1%)

[No beta particles emitted by Tc-99m]

Specific Gamma Ray Constant: 0.076 mrem/h at 1 meter per 1 mCi, or
760 mrem/h at 1 cm per 1 mCi

Physical Half-Life: 6.02 hours

Biological Half-Life: 24.00 hours

Effective Half-Life: 4.80 hours

Specific Activity: 5,243,820 curies/gram ("carrier free"/pure Tc-99m)
3.4 x 10⁶ curies/gram (^{99m}Tc-pertechnetate form)

RADIOLOGICAL DATA

Critical Organ (Biological Destination):* Total Body

Carrier or compound (radiopharmaceutical) dependent

Tc-99m Pertechnetate (^{99m}TcO₄) - (MUGA Scans) behaves similar to iodine and concentrates in thyroid, salivary glands, brain, blood pool, urinary bladder, and stomach. Stomach receives majority of dose and contains 25% of administered dose after 4 hours.

Tc-99m-Labeled Sulfur Colloid - approximately 70-80% of the administered dose (3 mCi/injected) is localized in the liver. Used for liver, spleen, and bone-marrow scanning.

Tc-99m-Labeled Macroaggregated Albumin (^{99m}Tc MAA) - primarily used for lung scanning; 90-95% of administered dose (3mCi/injected) is trapped in the capillary bed of the lungs within a few seconds after intravenous administration.

Tc-99m (MUGA) - spleen receives approximately 2.6 rad/mCi.

Tc-99m (DTPA) - brain or kidney scan; administered dose is 20 mCi (injected); bladder (0.5 rad/mCi); whole body (20 mrad/mCi)

Routes of Intake: Ingestion, Inhalation, Puncture/Injection, Wound, Skin Contamination (Absorption)

External & internal exposure **and** contamination concerns from Tc-99m

Committed Dose Equivalent (CDE): 0.407 mrem / uCi (puncture/thyroid/adult)
(Organ Doses) 0.313 mrem / uCi (ingestion/thyroid)
0.186 mrem / uCi (inhalation/thyroid)

Annual Limit on Intake (ALI):

80 mCi (all compounds)* (oral ingestion / CEDE / Whole Body / 5 rem)

* (all compounds, except oxides hydroxides, halides, and nitrates)

200 mCi (all compounds) (inhalation / CEDE / WB / 5 rem / Class "D")

200 mCi (all compounds) (inhalation / CEDE / WB / 5 rem / Class "W")

* [1.0 ALI = 80 mCi ingested = 5,000 millirem CEDE / Whole Body]
[1.0 ALI = 200 mCi inhaled = 5,000 millirem CEDE / WB / Class "D"]

Skin Contamination Dose Rate (Basal Cells): 718 millirad/hour per uCi/cm²

* [Dose to basal cells at a depth of 7 mg/cm² or 0.007 cm in tissue without air reflection]

Skin Contamination Dose Rate (Extremity Skin): Negligible

* [Dose to skin of extremities at a tissue depth of 30-50 mg/cm² of 0.03 cm]

SHIELDING:

¼" – ½" lead shielding is adequate for Tc-99m 140 keV gammas

Half-Value Layer (HVL / Lead): 0.027 cm = 0.011 in (140 keV)

Tenth-Value Layer (TVL / Lead): 0.083 cm = 0.033 in (140 keV)

Tenth-Value Layer (TVL / Concrete): 6.60 cm = 2.60 in

Half-Value Layer (HVL / Water or Tissue): 4.60 cm = 1.81 in

Attenuation Coefficient (100): 0.16 cm = 0.063 in (lead)

Attenuation Coefficient (1000): 0.25 cm = 0.104 in (lead)

SURVEY INSTRUMENTATION:

Survey meter equipped with a 1" x 1" or a low-energy NaI scintillation probe is preferred for the detection of Tc-99m contamination. Typical counting efficiencies: [1" x 1" NaI probe (39%)] and [low-energy NaI probe (12% / Ludlum and 18% / Bicon)].

Survey meters equipped with a G-M pancake/frisker (15.5 cm² surface area) can be used; however, they exhibit very low counting efficiencies (approximately, 1.2%) for the detection of low-energy Tc-99m gamma rays. G-M probes are only effective for gross Tc-99m contamination.

Indirect counting using a liquid scintillation counter (LSC), gamma counter, or gas proportional counter (GPC) should be used to detect removable Tc-99m contamination on smears, swabs, or swipes.

PERSONNEL RADIATION MONITORING DOSIMETERS (Whole Body and Finger Tabs):
REQUIRED when handling > 5.0 millicurie of Tc-99m at **any** time.

DOSE RATES from unshielded 1.0 millicurie isotropic point source of Tc-99m:

<u>DISTANCE</u>	<u>MILLIREM/HOUR</u>
1.00 cm	760.00
10.00 cm	7.60
100.00 cm	0.076
6.0 in	3.270

REGULATORY COMPLIANCE INFORMATION (10 CFR 20 / Appendix B)

Derived Air Concentration (DAC): (Occupational)	6.0E-5 uCi/cc (Class "D") 1.0E-4 uCi/cc (Class "W")
Airborne Effluent Release Limit: [*] (Annual Average)	2.0E-7 uCi/cc (Class "D") 3.0E-7 uCi/cc (Class "W")

* [Applicable to the assessment & control of dose to the public (10 CFR 20.1302). If this concentration was inhaled continuously for over one year the resulting TEDE would be 50 millirem].

Unrestricted Area Removable Contamination Limit:	1,000 dpm / 100 cm ²
Posting Areas or Rooms [10 CFR 20.1902(e)]:	> 10 mCi
Container Labeling Quantity [10 CFR 20.1905]:	≥ 1 mCi
Exempt Quantity [Old 10 CFR 30.18]:	100 uCi
Limited Quantity [DOT / 49 CFR 173.425]	≤ 21.6 mCi
Type A Quantity [DOT / 49 CFR 173.425]: [*]	> 21.6 mCi

* [**Requires** a Certified DOT Type A Transport Container]

Reportable Quantity ["RQ" / 49 CFR 172.101]: [*]	100 Ci
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* [Initials "RQ" **must** be indicated on transfer/shipping forms & labels]

Urinalysis: Not Required; however, may be requested by RSS personnel after a radioactive spill of Tc-99m or a suspected intake.

GENERAL RADIOLOGICAL SAFETY INFORMATION

Inherent Volatility (STP): Insignificant / Negligible

Tc-99m is used in clinical and research diagnostic scanning and imaging.

Whole body & extremity exposures, skin contamination (dose), ingestion, inhalation, puncture/injection, absorption through skin, and area contamination are primary radiological safety concerns.

Drying can cause airborne Tc-99m dust contamination and rapid boiling can cause airborne Tc-99m aerosol contamination. Expelling Tc-99m solutions through syringe needles and pipette tips can generate airborne aerosols.

Always wear a lab coat and disposable gloves when handling Tc-99m.

Monitor personnel, work areas, and floors using a survey meter equipped with a 1" x 1" or a low-energy NaI scintillation probe for Tc-99m contamination. A survey meter equipped with a G-M pancake/frisker probe (15.5 cm² surface area) can be used for the detection of gross Tc-99m contamination.

Monitor for removable surface contamination by smearing, swiping, swabbing, or wipe-testing where Tc-99m is used. Count smears or swabs in a liquid scintillation counter (LSC), gas proportional counter (GPC), or a gamma counter.

Technetium-99m, in the form of sodium pertechnetate (Na^{99m}TcO₄), is easily obtained from a ⁹⁹Mo-^{99m}Tc ("molly") generator. Typical dose administered is 10 mCi via ingestion (GI Tract Stomach Wall: 51 mrem/mCi, Thyroid: 1300 mrem/mCi, Upper Large Intestine Wall: 120 mrem/mCi). Imaging time is typically 30-minutes after administration. Moly-generators are generally replaced weekly in the UMH Nuclear Pharmacy.

Technetium-99m pertechnetate (^{99m}TcO₄) is obtained directly from the "molly" generator using saline as the eluting solution. This radiopharmaceutical is used for brain, thyroid, salivary gland, and stomach scanning. Typical adult dose is 15 millicuries.

Separation of daughter Tc-99m from parent Mo-99 is usually accomplished by eluting a moly-generator with sterile normal saline solution.

Tc-99m Pertechnetate: brain, thyroid, stomach, salivary gland scans

Tc-99m Sulfur Colloid: liver imaging [delivered intravenous dose: 1-8 mCi (3 mCi) / 338 mrad/mCi / imaging time is 30-minutes after injection]; spleen imaging (delivered intravenous dose: 1-8 mCi / 213 mrad/mCi), and bone marrow scans (delivered intravenous dose: 3-12 mCi / 27.5 mrem/mCi). Oral administration doses are generally 500 uCi.

Tc-99m Macroaggregated Albumin (^{99m}Tc MAA): lung scans; typical administered dose is 3 mCi Tc-99m/injection; imaging time is within 2-3 minutes; lung imaging dose (22 mrad/mCi).

TRAI99M

ORIGINAL: APRIL 1994 (MLD)
REVISION: AUGUST 1998 (STU/MLD)