ENVIRONMENT, HEALTH & SAFETY
UNIVERSITY OF MICHIGAN

Thallium - 201

Radiological Safety Guidance

Revision Date: 09/20/18

Physical Data

GAMMA ENERGIES
• 70.8 keV (46.5% abundance)
• 68.9 keV (27.4%)
• 80.3 keV (20.5%)
• 167.4 keV (10.0%)
• 135.3 keV (2.7%)

- No beta particles emitted by Tl-201
- Specific Gamma Ray Constant: 0.0441 mrem/hour at 1 meter per 1 millicurie or 441 mrem/hour at 1 cm per millicurie

Physical Half-Life	3.04 days (73.06 hours)
Biological Half-Life	5.00 days (Tl-201 Solution)
Effective Half-Life	1.89 days (Tl-201 Solution)

Biological Half-Life	11.00 days (Thallous Chloride)
Effective Half-Life	2.40 days (Thallous Chloride)

Specific Activity	2.159 x 105 curies/gram (calculated)

Shielding

Half-Value Layer (HVL/lead)	0.006mm = 0.0006cm
Tenth-Value Layer (TVL/10/lead)	0.15 mm = 0.015 cm = 0.006"
Attenuation Coefficient (100/lead)	0.98 mm = 0.098 cm = 0.039"
Attenuation Coefficient (1,000/lead)	2.10 mm = 0.210 cm = 0.083"
Attenuation Coefficient (10,000/lead)	3.30 mm = 0.330 cm = 0.130"

Volatility

Inherent Volatility (STP): Insignificant/Negligible

Exposure: Radiological Safety Information

- Tl-201 is used in clinical and research diagnostic scanning and imaging.
- Tl-201 (Thallous Chloride) is supplied in isotonic solution as a sterile, non-pyrogenic diagnostic radiopharmaceutical for intravenous administration. Thallous ions mimic potassium's biological behavior.
- Recommended radiopharmaceutical dose is approximately 1-2 millicuries.
- Mainly used for detection of myocardial infarction (cell damage due to lack of oxygen to cells) and/or ischemia [reduced blood flow due to restriction or actual obstruction of a blood vessel or coronary artery (myocardial ischemia)].
- In a cardiac perfusion study using Tl-201 chloride, an abnormality is demonstrated by the absence of activity or greatly reduced activity in the area of the myocardium.

Exposure Rates

DISTANCE	MILLIREM/HOUR
1.00 cm	441.00
10.00 cm	4.41
100.00	0.044
6 in	1.9

Exposure Prevention

- **Always** wear a lab coat and disposable gloves when handling Tl-201.
- Not known if Tl-201 is excreted in human milk (nursing mothers)

Engineering Controls

- Drying can cause airborne Tl-201 dust contamination and rapid boiling can cause airborne Tl-201 aerosol contamination.
- Expelling Tl-201 solutions through syringe needles and pipette tips can generate airborne aerosols.

Personal Safety

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

Regulatory Compliance Limits (10 CFR 20/Appendix B)

REGULATION	UNIT OF MEASURE	NOTES
Derived Air Concentration (DAC) Occupational	9.0E-6 uCi/mL (all compounds)	
Airborne Effluent Release Limit (Annual Average)	3.0E-8 uCi/mL (all compounds)	Applicable to the assessment and control of dose to the public (10 CFR 20.1302). If this concentration were inhaled continuously for over one year the resulting TEDE would be 50 millirem
Unrestricted Area Removable Contamination Limit	1,000 dpm/100 cm^2	
Container Labeling Quantity (10 CFR 20.1905)	≥1 mCi	
Urinanlysis	Not Required	However, may be requested by RSS personnel after a radioactive spill or a suspected intake.

Annual Limit on Intake (ALI)

- 20 mCi (all compounds/oral ingestion/CEDE/Whole Body/5 rem)
  - 1.0 ALI = 20 mCi ingested = 5,000 millirem CEDE/Whole Body
- 20 mCi (all compounds/inhalation/Class "D"/CEDE/WB/5 rem)

Contamination

Radiological Data

Critical Organ (Biological Destination)	Lower Large Intestine
Critical Organs (iThallous Chloride)	Kidney, Heart, Whole Body
Target Organ for Radiopharmaceuticals	Heart (Stress Tests)
Carrier or compound (radiopharmaceutical) dependent	
Routes of Intake	• Ingestion • Inhalation • Puncture/Injection • Wound • Skin Contamination (Absorption)
External and internal exposure and contamination concerns from Tl-201	Committed Dose Equivalent (CDE) (Organ Doses) • 1.00 mrem/uCi (puncture/maximum organ)

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

Skin Contamination (TI - 201)

- Skin Contamination Dose Rate (electrons): 844 mrem/hour per uCi/cm2
  - Dose to basal cells at a tissue depth of 7 mg/cm2 or 0.007 cm in tissue with no air reflection
- Skin Contamination Dose Rate (Extremity Skin/e- dose): Negligible
  - Dose to skin of extremities at a tissue depth of 30-50 mg/cm2 or 0.03 cm

Internal Contamination

- Tl-201 (intravenous injection) is used in conjunction with maximum exercise stress testing for myocardial imaging.
- Thallous Chloride (Tl-201) clears rapidly from the blood with maximum concentration by normal myocardium within about 10 minutes; other organs include the thyroid, liver, kidneys, and stomach.

Detect Contamination

Survey Instrumentation

- Monitor for removable surface contamination by smearing, swiping, swabbing, or wipe-testing where Tl-201 is used. Count smears or swabs in a liquid scintillation counter (LSC) or gamma counter.
- Monitor personnel, work areas, and floors using a survey meter equipped with a 1" x 1" or a low-energy NaI scintillation probe for Tl-201 contamination. A survey meter equipped with a G-M pancake/frisker probe (15.5 cm2 surface area) should NOT be used for the detection of Tl-201.
- Survey meter equipped with a 1" x 1" or a low-energy NaI scintillation probe is preferred for the detection of Tl-201 contamination.
- Surveys meters equipped with a G-M pancake/frisker (15.5 cm2 surface area) should NOT be used because they exhibit such low counting efficiency (< 0.5%) for the detection of low-energy Tl-201 gamma rays.
- Indirect counting using a liquid scintillation counter (LSC) or gamma counter should be used to detect removable Tl201 contamination on smears, swabs, or swipes.

Required Personal Radiation Monitoring

Dosimeters (Whole Body and Finger Tabs): **Required** when handling > 1.0 millicurie of Tl-201 at any time.