# ³H Nuclide Safety Data Sheet

**Hydrogen-3 [Tritium]**

## I. PHYSICAL DATA

<table>
<thead>
<tr>
<th>Radiation: Beta (100% abundance)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy:</td>
</tr>
<tr>
<td>Max.: 18.6 keV; Average: 5.7 keV</td>
</tr>
<tr>
<td>Half-Life [T(\frac{1}{2})]:</td>
</tr>
<tr>
<td>Physical T(\frac{1}{2}): 12.3 years</td>
</tr>
<tr>
<td>Biological T(\frac{1}{2}): 10 - 12 days</td>
</tr>
<tr>
<td>Effective T(\frac{1}{2}): 10 - 12 days*</td>
</tr>
</tbody>
</table>

* Large liquid intake (3-4 liters/day) reduces effective T\(\frac{1}{2}\) by a factor of 2+; ³H is easily flushed from the body

<table>
<thead>
<tr>
<th>Specific Activity: 9650 Ci/g [357 TBq/g] max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beta Range:</td>
</tr>
<tr>
<td>Air: 6 mm [0.6 cm; 0.25 inches]</td>
</tr>
<tr>
<td>Water: 0.006 mm [0.0006 cm; 3/10,000 inches]</td>
</tr>
<tr>
<td>Solids/Tissue: Insignificant [No ³H betas pass through the dead layer of skin]</td>
</tr>
</tbody>
</table>

## II. RADIOLOGICAL DATA

<table>
<thead>
<tr>
<th>Radiotoxicity: Least radiotoxic of all nuclides; CEDE, ingestion or inhalation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tritiated water: 1.73E-11 Sv/Bq (0.064 mrem/uCi) of ³H intake</td>
</tr>
<tr>
<td>Organic Compounds: 4.2E-11 Sv/Bq (0.16 mrem/uCi) of ³H intake</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Critical Organ: Body water or tissue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposure Routes: Ingestion, inhalation, puncture, wound, skin contamination absorption</td>
</tr>
<tr>
<td>Radiological Hazard: External Exposure - None from weak ³H beta</td>
</tr>
<tr>
<td>Internal Exposure &amp; Contamination - Primary concern</td>
</tr>
</tbody>
</table>

## III. SHIELDING

None required - not an external radiation hazard

## IV. DOSIMETRY MONITORING

Urine bioassay is the only readily available method to assess intake [for tritium, no intake = no dose]
Be sure to provide a urine sample to Radiation Safety for confirmatory bioassay whenever your annual ³H use exceeds 8 mCi. If negative, no further bioassay is required unless use exceeds 100 mCi at one time or 1000 mCi in one year, or after any accident/incident in which an intake is suspected

## V. DETECTION & MEASUREMENT

Liquid Scintillation Counting is the only readily available method for detecting ³H
NOTE: PORTABLE SURVEY METERS WILL NOT DETECT LABORATORY QUANTITIES OF ³H

## VI. SPECIAL PRECAUTIONS

- Avoid skin contamination [absorption], ingestion, inhalation, & injection [all routes of intake]
- Many tritium compounds readily penetrate gloves and skin; handle such compounds remotely and wear double gloves, changing the outer pair at least every 20 minutes.
- While tritiated DNA precursors are considered more toxic than ³H₂O, they are generally less volatile and hence do not normally present a greater hazard
- The inability of direct-reading instruments to detect tritium and the slight permeability of most material to [tritiated] water & hydrogen [tritium] facilitates undetected spread of contamination. Use extreme care in handling and storage [e.g. sealed double or multiple containment] to avoid contamination, especially with high specific activity compounds.
I. PHYSICAL DATA

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiation</td>
<td>Beta (100% abundance)</td>
</tr>
<tr>
<td>Energy: Max.</td>
<td>156 keV; Average: 49 keV</td>
</tr>
<tr>
<td>Physical $T_{1/2}$</td>
<td>5730 years</td>
</tr>
<tr>
<td>Biological $T_{1/2}$</td>
<td>12 days</td>
</tr>
<tr>
<td>Effective $T_{1/2}$</td>
<td>Bound - 12 days; unbound - 40 days</td>
</tr>
<tr>
<td>Specific Activity</td>
<td>4.46 Ci/g [0.165 TBq/g] max.</td>
</tr>
<tr>
<td>Beta Range: Air</td>
<td>24 cm [10 inches]</td>
</tr>
<tr>
<td>Beta Range: Water/Tissue</td>
<td>0.28 mm [0.012 inches]</td>
</tr>
<tr>
<td>Beta Range: Plastic</td>
<td>0.25 mm [0.010 inches]</td>
</tr>
<tr>
<td>~1% of $^{14}$C betas transmitted through dead skin layer, i.e. 0.007 cm depth</td>
<td></td>
</tr>
</tbody>
</table>

II. RADIOLOGICAL DATA

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiotoxicity</td>
<td>0.023 mrem/uCi of $^{14}$CO$_2$ inhaled;</td>
</tr>
<tr>
<td></td>
<td>2.09 mrem/uCi organic compounds inhaled/ingested</td>
</tr>
<tr>
<td>Critical Organ</td>
<td>Fat tissue [most labeled compounds]; bone [some labeled carbonates]</td>
</tr>
<tr>
<td>Exposure Routes</td>
<td>Ingestion, inhalation, puncture, wound, skin contamination absorption</td>
</tr>
<tr>
<td>Radiological Hazard</td>
<td>External Exposure – None from weak $^{14}$C beta</td>
</tr>
<tr>
<td></td>
<td>Internal Exposure &amp; Contamination - Primary concern</td>
</tr>
</tbody>
</table>

III. SHIELDING

None required - mCi quantities not an external radiation hazard

IV. DOSIMETRY MONITORING

Urine bioassay is the most readily available method to assess intake [for $^{14}$C, no intake = no dose]
Provide a urine sample to Radiation Safety after any accident/incident in which an intake is suspected

V. DETECTION & MEASUREMENT

<table>
<thead>
<tr>
<th>Survey Meters</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geiger-Mueller</td>
<td>~10%</td>
</tr>
<tr>
<td>Beta Scintillator</td>
<td>~5%</td>
</tr>
</tbody>
</table>

Wipe Test: Liquid Scintillation Counting is the best readily available method for counting $^{14}$C wipe tests

VI. SPECIAL PRECAUTIONS

- Avoid skin contamination [absorption], ingestion, inhalation, & injection [all routes of intake]
- Many $^{14}$C compounds readily penetrate gloves and skin; handle such compounds remotely and wear double gloves, changing the outer pair at least every 20 minutes.
I. PHYSICAL DATA

Radiation: Beta (100% abundance)
Energy: Maximum: 1,710 keV; Average: 695 keV
Half-Life: 
  - Physical $T_{1/2}$: 14.29 days
  - Biological $T_{1/2}$: Bone ~ 1155 days; Whole Body ~ 257 days
  - Effective $T_{1/2}$: 14.29 days
Specific Activity: 286,500 Ci/g [10,600 TBq/g] max.
Beta Range:
  - Air: 610 cm [240 inches; 20 feet]
  - Water/Tissue: 0.76 cm [0.33 inches]
  - Plastic: 0.61 mm [3/8 inches]

II. RADIOLOGICAL DATA

Radiotoxicity:
  - Inhaled: 94.7 mrem/uCi [Lung] & 15.5 mrem/uCi [CEDE] of $^{32}$P
  - Ingested: 29.9 mrem/uCi [Bone Marrow] & 8.77 mrem/uCi [CEDE] of $^{32}$P
Critical Organ:
  - Bone [soluble $^{32}$P]; Lung [Inhalation]; GI Tract [Ingestion - insoluble compounds]
Exposure Routes: Ingestion, inhalation, puncture, wound, skin contamination absorption
Radiological Hazard: External Exposure [unshielded dose rate at 1 mCi $^{32}$P vial mouth: approx. 26 rem/hr], Internal Exposure & Contamination

III. SHIELDING

Shield $^{32}$P with 3/8 inch Plexiglas and monitor for Bremstrahlung; If Bremstrahlung X-rays detected outside Plexiglas, apply 1/8 to 1/4 inch lead [Pb] shielding outside Plexiglas.
The accessible dose rate should be background but must be < 2 mR/hr

IV. DOSIMETRY MONITORING

Wear radiation dosimetry monitoring badges [body & ring] if regularly handling mCi quantities of $^{32}$P

V. DETECTION & MEASUREMENT

Portable Survey Meters: Geiger-Mueller
Wipe Test: Liquid Scintillation Counting is an acceptable method for counting $^{32}$P wipe tests

VI. SPECIAL PRECAUTIONS

- Avoid skin contamination [absorption], ingestion, inhalation, & injection [all routes of intake].
- Store $^{32}$P (including waste) behind Plexiglas shielding [3/8 inch thick]; survey (with GM meter) to check adequacy of shielding (accessible dose rate < 2 mR/hr; should be background); apply lead [Pb] shielding outside Plexiglas if needed.
- Use 3/8 inch Plexiglas shielding to minimize exposure while handling $^{32}$P.
- Use tools [e.g. Beta Blocks] to handle $^{32}$P sources and contaminated objects; avoid direct hand contact.
  - Always have a portable survey meter present and turned on when handling $^{32}$P.
- $^{32}$P is not volatile, even when heated, and can be ignored as an airborne contaminant unless aerosolized.

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1 NCRP Report No. 65, p.88
2 Federal Guidance Report No. 11 [Oak Ridge, TN; Oak Ridge National Laboratory, 1988], p. 122, 156
3 Dupont/NEN, Phosphorous-32 Handling Precautions [Boston, MA; NEN Products, 1985]
I. PHYSICAL DATA

Radiation: Beta (100% abundance)
Energy: Maximum: 248.5 keV; Average: 76.4 keV
Half-Life $[T_{1/2}]$:
  - Physical $T_{1/2}$: 25.3 days
  - Biological $T_{1/2}$: Bone ~ 1155 days; Whole Body ~ 257 days
  - Effective $T_{1/2}$: 25.3 days
Specific Activity: 156,000 Ci/g [5,780 TBq/g] max.
Beta Range:
  - Air: 50 cm [~ 20 inches]
  - Water/Tissue: 0.06 cm [0.024 inches]
  - Plastic: 0.05 cm [0.02 inches]

II. RADIOLOGICAL DATA

Radiotoxicity$^2$: 15.6 mrem/uCi [Lung] & 2.32 mrem/uCi [CEDE] of $^{33}$P inhaled
  1.85 mrem/uCi [Bone Marrow] & 0.92 mrem/uCi [CEDE] of $^{33}$P ingested
Critical Organ:
  Bone [soluble $^{33}$P]; Lung [Inhalation]; GI Tract [Ingestion - insoluble compounds]
Exposure Routes:
  Ingestion, inhalation, puncture, wound, skin contamination absorption
Radiological Hazard:
  External Exposure – mCi quantities not considered an external hazard
  Internal Exposure & Contamination - Primary concern

III. SHIELDING

None required - mCi quantities not an external radiation hazard

IV. DOSIMETRY MONITORING

Urine bioassay is the most readily available method to assess intake [for $^{33}$P, no intake = no dose].
Provide a urine sample to Radiation Safety after any accident/incident in which an intake is suspected.
No dosimetry badges needed when working with $^{33}$P [beta energy too low to be detected]

V. DETECTION & MEASUREMENT

Portable Survey Meters: Geiger-Mueller
Wipe Test: Liquid Scintillation Counting works well for counting $^{33}$P wipe tests

VI. SPECIAL PRECAUTIONS

- Avoid skin contamination [absorption], ingestion, inhalation, & injection [all routes of intake]
- $^{33}$P is not volatile, even when heated, and can be ignored as an airborne contaminant$^3$ unless aerosolized.

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$^1$ NCRP Report No. 65, p.88
I. PHYSICAL DATA

| Radiation: | Beta (100% abundance) |
| Energy: | Maximum: 167.47 keV; Average: 48.8 keV |
| Half-Life $[T_{1/2}]$: | Physical $T_{1/2}$: 87.44 days |
| Biological $T_{1/2}$: | 623 days [unbound $^{35}$S]; 90 days [bound $^{35}$S] |
| Effective $T_{1/2}$: | 44 - 76 days [unbound $^{35}$S] |

Specific Activity: 42,707 Ci/g [1,580 TBq/g] max.

Beta Range: Air: 26 cm [10.2 inches]
            Water/Tissue: 0.32 mm [0.015 inches]
            Plastic: 0.25 mm [0.010 inches]

II. RADIOLOGICAL DATA

Radiotoxicity$^1$: 2.48 mrem/uCi [CEDE] of $^{35}$S inhaled
0.733 mrem/uCi of $^{35}$S ingested

Critical Organ: Testis
Exposure Routes: Ingestion, inhalation, puncture, wound, skin contamination absorption
Radiological Hazard: External Exposure – None from weak $^{35}$S beta
                      Internal Exposure & Contamination - Primary concern

III. SHIELDING

None required - mCi quantities not an external radiation hazard

IV. DOSIMETRY MONITORING

Urine bioassay is the most readily available method to assess intake [for $^{35}$S, no intake = no dose]
Provide a urine sample to Radiation Safety after any accident/incident in which an intake is suspected

V. DETECTION & MEASUREMENT

Portable Survey Meters: Geiger-Mueller [-10% efficiency]
                        Beta Scintillator [-5% efficiency]

Wipe Test: Liquid Scintillation Counting is the best readily available method for counting $^{35}$S wipe tests

VI. SPECIAL PRECAUTIONS

- Avoid skin contamination [absorption], ingestion, inhalation, & injection [all routes of intake]
- Many $^{35}$S compounds and metabolites are slightly volatile and may create contamination problems if not sealed or otherwise controlled. This occurs particularly when $^{35}$S amino acids are thawed, and when they are added to cell culture media and incubated. Therefore vent thawing $^{35}$S vials in a hood. Incubators used with $^{35}$S will have an activated charcoal trap placed in the incubator. Possibility of volatilization must be taken into account when surveying after use.

$^1$ Federal Guidance Report No. 11 [Oak Ridge, TN; Oak Ridge National Laboratory, 1988], p. 122,156
# Calcium-45 Nuclide Safety Data Sheet

## I. PHYSICAL DATA

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiation</td>
<td>Beta (100% abundance)</td>
</tr>
<tr>
<td>Energy</td>
<td>Maximum: 257 keV; Average: 77 keV</td>
</tr>
<tr>
<td>Half-Life [T½]</td>
<td>Physical T½: 162.61 days</td>
</tr>
<tr>
<td></td>
<td>Biological T½: Bone ~ 18,000 days</td>
</tr>
<tr>
<td></td>
<td>Effective T½: 163 Days</td>
</tr>
<tr>
<td>Specific Activity</td>
<td>17,800 Ci/g [659 TBq/g] max.</td>
</tr>
<tr>
<td>Beta Range</td>
<td>Air: 52 cm [20 inches]</td>
</tr>
<tr>
<td></td>
<td>Water/Tissue: 0.062 cm [0.024 inches]</td>
</tr>
<tr>
<td></td>
<td>Plastic: 0.053 cm [0.021 inches]</td>
</tr>
</tbody>
</table>

## II. RADIOLOGICAL DATA

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiotoxicity²</td>
<td>35.8 mrem/uCi [Lung] &amp; 16.2 mrem/uCi [Bone] of $^{45}$Ca inhaled</td>
</tr>
<tr>
<td>Critical Organ</td>
<td>Bone, Lung [Inhalation]</td>
</tr>
<tr>
<td>Exposure Routes</td>
<td>Ingestion, inhalation, puncture, wound, skin contamination absorption</td>
</tr>
<tr>
<td>Radiological Hazard</td>
<td>External Exposure - mCi quantities not considered an external hazard</td>
</tr>
<tr>
<td></td>
<td>Internal Exposure &amp; Contamination - Primary concern</td>
</tr>
</tbody>
</table>

## III. SHIELDING

None required - mCi quantities not an external radiation hazard

## IV. DOSIMETRY MONITORING

Urine bioassay is the most readily available method to assess intake. Provide a urine sample to Radiation Safety after any accident/incident in which an intake is suspected. No dosimetry badges needed to work with mCi quantities of $^{45}$Ca.

## V. DETECTION & MEASUREMENT

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portable Survey Meters</td>
<td>Geiger-Mueller</td>
</tr>
<tr>
<td>Wipe Test</td>
<td>Liquid Scintillation Counting works well for counting $^{45}$Ca wipe tests</td>
</tr>
</tbody>
</table>

## VI. SPECIAL PRECAUTIONS

- Avoid skin contamination [absorption], ingestion, inhalation, & injection [all routes of intake]

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1 “Calcium-45 Handling Precautions”, E.I. DuPont de Numours & Co., NEN Products [Boston, MA; 1985]
2 Federal Guidance Report No. 11 [Oak Ridge, TN; Oak Ridge National Laboratory, 1988], p. 122, 156
I. PHYSICAL DATA

Radiation:  Gamma - 320 keV (9.8% abundance)  
          X-ray - 5 keV (22% abundance)  
Gamma Constant: 0.018 mR/hr per mCi @ 1.0 meter  
          [6.32E-6 mSv/hr per MBq @ 1.0 meter]¹ 
Half-Life [T½]:  
          Physical T½: 27.7 days  
          Biological 616 days  
          Effective T½: 26.6 days (whole body)  
Specific Activity: 9.24E4 Ci/g [3.42E3 TBq/g] max.

II. RADIOLOGICAL DATA

Radiotoxicity: 0.145 mrem/uCi of ⁵¹Cr ingested [CEDE]  
               0.334 mrem/uCi of ⁵¹Cr inhaled [CEDE]  
Critical Organ: Lower Large Intestine [LLI]  
Intake Routes: Ingestion, inhalation, puncture, wound, skin contamination (absorption);  
               Radiological Hazard: External & Internal Exposure; Contamination

III. SHIELDING

<table>
<thead>
<tr>
<th>Material</th>
<th>Half Value Layer [HVL]</th>
<th>Tenth Value Layer [TVL]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead [Pb]</td>
<td>2 mm (0.07 inches)</td>
<td>6.6 mm (0.23 inches)</td>
</tr>
<tr>
<td>Concrete</td>
<td>2.8 cm (1.1 inches)</td>
<td>9.3 cm (3.7 inches)</td>
</tr>
<tr>
<td>Plexiglas</td>
<td>4.8 cm (1.9 inches)</td>
<td>16 cm (6.3 inches)</td>
</tr>
</tbody>
</table>

The accessible dose rate should be background but must be < 2 mR/hr

IV. DOSIMETRY MONITORING

Wear radiation dosimetry monitoring badges [body & ring] when handling ⁵¹Cr

V. DETECTION & MEASUREMENT

Portable Survey Meters: Geiger-Mueller  
Wipe Test: Liquid Scintillation Counter

VI. SPECIAL PRECAUTIONS

- Store ⁵¹Cr (including waste) behind lead shielding [¼ - ½ inch thick]; survey (with GM meter) to check adequacy of shielding (accessible dose rate < 2 mR/hr; should be background)  
- Avoid skin contamination [absorption], ingestion, inhalation, & injection [all routes of intake]  
- Use shielding to minimize exposure while handling ⁵¹Cr  
- Use tools to handle ⁵¹Cr sources and contaminated objects; avoid direct hand contact

¹ Health Physics & Radiological Health Handbook, 3rd Ed. [Baltimore, MD; Williams & Wilkins, 1998] p. 6-9
I. PHYSICAL DATA

Radiation:  
- Gamma: 141 keV (89% abundance)  
- X-rays: 18 keV (6% abundance), 21 keV (1.2% abundance)

Gamma Constant: 0.77 R/hr at 1 cm from an unshielded 1 mCi point source

Half-Life \( T_{\frac{1}{2}} \) :  
- Physical \( T_{\frac{1}{2}} \): 6.0 hours  
- Biological \( T_{\frac{1}{2}} \): ~ 1 day  
- Effective \( T_{\frac{1}{2}} \): ~ 4.8 hours

Specific Activity: 5.27E6 Ci/g [1.95E17 Bq/g]

II. RADIOLOGICAL DATA

Radiotoxicity:  
- 63 mrem/mCi [1.7E-8 mSv/Bq] of \(^{99m}\)Tc ingested [CEDE]
- 27 mrem/mCi [7.21E-9 mSv/Bq] of \(^{99m}\)Tc inhaled [CEDE]

Critical Organ: Thyroid Gland; Upper GI tract

Exposure Routes: Ingestion, inhalation, puncture, wound, skin contamination absorption

Radiological Hazard: External & Internal Exposure; Contamination

III. SHIELDING

<table>
<thead>
<tr>
<th>Material</th>
<th>Half Value Layer (HVL)</th>
<th>Tenth Value Layer (TVL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead [Pb]</td>
<td>&lt;1 mm (&lt;0.035 inches)</td>
<td>1 mm (0.035 inches)</td>
</tr>
</tbody>
</table>

- The accessible dose rate should be background but must be < 2 mR/hr

IV. DOSIMETRY MONITORING

- Always wear radiation dosimetry monitoring badges [body & ring] whenever handling \(^{99m}\)Tc
- Submit a urine sample to Radiation Safety two to 24 hours [i.e. As Soon As Possible] after any suspected intake of \(^{99m}\)Tc; alert Radiation Safety of the short half-lived nuclide involved.

V. DETECTION & MEASUREMENT

Portable Survey Meters Geiger-Mueller

Wipe Test: Liquid Scintillation Counter or Gamma Counter

VI. SPECIAL PRECAUTIONS

- Store \(^{99m}\)Tc behind ¼-inch (~ 0.6 cm) thick lead (Pb) shielding
- Use tools to indirectly handle unshielded sources and potentially contaminated vessels; avoid direct hand contact
- Ensure that an appropriate, operational survey meter is present in the work area and turned on whenever \(^{99m}\)Tc is handled, so that any external exposure issues will be immediately apparent and hence quickly addressed
- Shield waste containers as needed to maintain accessible dose rate ALARA and < 2 mR/hr

1 Dupont/NEN, Technetium-99-m Handling Precautions (Boston, MA: NEN, 1985)
3 Federal Guidance Report No. 11 (Oak Ridge TN; Oak Ridge National Laboratory, 1988) P. 130, 162
I. PHYSICAL DATA

Primary Radiation: Gamma – 245 keV (94% abundance), 171 keV (90% abundance), 23 keV (69% abundance)

Gamma Constant: 8.9E-6 mrem/hr at 30 cm from 1 mCi [9.9E-4 mSv/hr at 30 cm from 1 MBq]

Physical Half-Life $[T_{1/2}]$ : 2.80 days

Specific Activity: 4.19E5 Ci/g [1.55E16 Bq/g]

II. RADIOLOGICAL DATA

Radiotoxicity: 1,330 mrem/mCi [3.59E-7 mSv/Bq] of $^{111}$In ingested [CEDE]$^1$

Critical Organ: Lower Large Intestine

Intake Routes: Ingestion, inhalation, puncture, wound, skin contamination (absorption)

Radiological Hazard: Internal and External Exposure, Contamination

III. SHIELDING

<table>
<thead>
<tr>
<th>Material</th>
<th>Half Value Layer [HVL]</th>
<th>Tenth Value Layer [TVL]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead [Pb]</td>
<td>&lt;1 mm (&lt;0.035 inches)</td>
<td>3 mm (0.035 inches)</td>
</tr>
</tbody>
</table>

→ The accessible dose rate should be background but must be < 2 mR/hr

IV. DOSIMETRY MONITORING

• Always wear radiation dosimetry monitoring badges [body & ring] whenever handling $^{111}$In

V. DETECTION & MEASUREMENT

Portable Survey Meters:

- Geiger-Mueller
- Wipe Test: Gamma counter

VI. SPECIAL PRECAUTIONS

- Store $^{111}$In behind ⅛-inch (~ 0.6 cm) thick lead (Pb) shielding
- Use tools to indirectly handle unshielded sources and potentially contaminated vessels; avoid direct hand contact
- Ensure that an appropriate, operational survey meter is present in the work area and turned on whenever $^{111}$In is handled, so that any external exposure issues will be immediately apparent and hence quickly addressed
- Shield waste containers as needed to maintain accessible dose rate ALARA and < 2 mR/hr


$^2$ Federal Guidance Report No. 11 (Oak Ridge TN; Oak Ridge National Laboratory, 1988) P. 130, 162
I. PHYSICAL DATA

- Radiation:
  - Gamma - 35.5 keV (7% abundance)
  - X-ray - 27 keV (113% abundance)

- Gamma Constant: 0.27 mR/hr per mCi @ 1.0 meter \[7.432E-5 mSv/hr per MBq @ 1.0 \text{ meter}^1\]

- Half-Life \( T_{1/2} \):
  - Physical \( T_{1/2} \): 60.14 days
  - Biological \( T_{1/2} \): 120-138 days (unbound iodine)
  - Effective \( T_{1/2} \): 42 days (unbound iodine)

- Specific Activity: 1.73E4 Ci/g \[642 \text{ TBq/g}\] max.

II. RADIOLOGICAL DATA

- Radiotoxicity\(^2\):
  - 3.44E-7 Sv/Bq (1273 mrem/uCi) of \(^{125}\text{I}\) ingested [Thyroid]
  - 2.16E-7 Sv/Bq (799 mrem/uCi) of \(^{125}\text{I}\) inhaled [Thyroid]

- Critical Organ: Thyroid Gland

- Intake Routes: Ingestion, inhalation, puncture, wound, skin contamination (absorption);

- Radiological Hazard: External & Internal Exposure; Contamination

III. SHIELDING

<table>
<thead>
<tr>
<th>Material</th>
<th>Half Value Layer [HVL]</th>
<th>Tenth Value Layer [TVL]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead [Pb]</td>
<td>0.02 mm (0.0008 inches)</td>
<td>0.07 mm (0.003 inches)</td>
</tr>
</tbody>
</table>

- The accessible dose rate should be background but must be < 2 mR/hr

IV. DOSIMETRY MONITORING

- Always wear radiation dosimetry monitoring badges [body & ring] whenever handling > 10 \(\mu\text{Ci}\) of \(^{125}\text{I}\)
- Conduct a baseline thyroid scan prior to first use of 1 mCi or more of radioactive iodine
- Conduct thyroid scan no earlier than 6 hours but within 72 hours of handling 1 mCi or more of \(^{125}\text{I}\) or after any suspected intake

V. DETECTION & MEASUREMENT

- Portable Survey Meters:
  - Geiger-Mueller
    - Low Energy Gamma Detector \([-19\% \text{ eff. for } ^{125}\text{I}]\) for contamination surveys
- Wipe Test: Liquid Scintillation Counter or Gamma Counter

VI. SPECIAL PRECAUTIONS

- Avoid skin contamination [absorption], ingestion, inhalation, & injection [all routes of intake]
- Use shielding [lead or leaded Plexiglas] to minimize exposure while handling mCi quantities of \(^{125}\text{I}\)
- Avoid making low pH [acidic] solutions containing \(^{125}\text{I}\) to avoid volatilization
- For iodinations:
  - Use a cannula adapter needle to vent stock vials of \(^{125}\text{I}\) used; this prevents puff releases
  - Cover test tubes used to count or separate fractions from iodinations with parafilm or other tight caps to prevent release while counting or moving outside the fume hood.

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1 Health Physics & Radiological Health Handbook, 3rd Ed. [Baltimore, MD: Williams & Wilkins, 1998] p. 6-11
2 Federal Guidance Report No. 11 (Oak Ridge TN; Oak Ridge National Laboratory, 1988) P. 136, 166
I. PHYSICAL DATA
Radiation: Gammas & X-rays: primary 364 keV (81% abundance); others 4 – 723 keV
Betas: primary 606 keV (89% abundance); others 248 – 807 keV
Gamma Constant: 0.28 mR/hr per mCi @ 1.0 meter \[7.647 \times 10^{-5} \text{ mSv/hr per MBq @ 1.0 meter}\]¹
Half-Life \[T_{1/2}\]:
  - Physical \[T_{1/2}\]: 8.04 days
  - Biological \[T_{1/2}\]: 120-138 days (unbound iodine)
  - Effective \[T_{1/2}\]: 7.6 days (unbound iodine)
Specific Activity: 1.24E5 Ci/g \[4,600 \text{ TBq/g}\] max.

II. RADIOLOGICAL DATA
Radiotoxicity²: 4.76 E-7 Sv/Bq (1.76 rem/uCi) of \(^{131}\text{I}\) ingested [Thyroid]
  2.92 E-7 Sv/Bq (1.08 rem/uCi) of \(^{131}\text{I}\) inhaled [Thyroid]
Critical Organ: Thyroid Gland
Intake Routes: Ingestion, inhalation, puncture, wound, skin contamination (absorption);
Radiological Hazard: External & Internal Exposure; Contamination

III. SHIELDING
  - Half Value Layer [HVL]: 3 mm (0.12 inches)
  - Tenth Value Layer [TVL]: 11 mm (0.43 inches)
→ The accessible dose rate should be background but must be < 2 mR/hr

IV. DOSIMETRY MONITORING
- Always wear radiation dosimetry monitoring badges [body & ring] whenever handling \(^{131}\text{I}\)
- Conduct a baseline thyroid scan prior to first use of radioactive iodine
- Conduct thyroid scan no earlier than 6 hours but within 72 hours of handling 1 mCi or more of \(^{131}\text{I}\) or after any suspected intake

V. DETECTION & MEASUREMENT
Portable Survey Meters:
  - Geiger-Mueller to assess shielding effectiveness & contamination
Wipe Test:
  - Liquid Scintillation Counter or Gamma Counter

VI. SPECIAL PRECAUTIONS
- Avoid skin contamination [absorption], ingestion, inhalation, & injection [all routes of intake]
- Use shielding [lead or leaded Plexiglas] to minimize exposure while handling mCi quantities of \(^{131}\text{I}\)
- Avoid making low pH [acidic] solutions containing \(^{131}\text{I}\) to avoid volatilization
- For iodinations:
  - Use a cannula adapter needle to vent stock vials of \(^{131}\text{I}\) used; this prevents puff releases
  - Cover test tubes used to count or separate fractions from iodinations with parafilm or other tight caps to prevent release while counting or moving outside the fume hood.

¹ Health Physics & Radiological Health Handbook, 3rd Ed. [Baltimore, MD; Williams & Wilkins, 1998] p. 6-11
² Federal Guidance Report No. 11 (Oak Ridge TN; Oak Ridge National Laboratory, 1988) P. 136, 166