IODINE - 131
[I-131]

PHYSICAL DATA

Gamma Energies:	364 keV (82% abundance)	723 keV (2% abundance)
	637 keV (7% abundance)	80 keV (3% abundance)
	284 keV (6% abundance)	29-34 keV (4.5% / x-rays)

Beta Energies: 192 keV (89% abundance / average)
606 keV (89% abundance / maximum)

- Beta particles with energies of 70 keV and 795 keV can penetrate the dead layer of skin and lens of the eye, respectively.

- Fraction of I-131 beta particles (606 keV) transmitted through the dead layer of skin (0.007 cm) is approximately 80%.

Physical Half-Life:	8.05 days
Biological Half-Life:	138 days
Effective Half-Life:	7.60 days
Specific Gamma Constant:	0.22 mR/h at 1.0 meter per millicurie
Specific Activity:	124,068 curies/gram
Maximum Beta Range in Water:	2 mm = 0.20 cm = 0.08 in
Maximum Beta Range in Air:	165 cm = 65.0 in = 5.40 ft

RADIOLOGICAL DATA

- Critical Organ (Biological Destination): Thyroid
- Routes of Intake: Inhalation, Ingestion, Puncture, Wound, Skin Contamination (Absorption)
- External & internal exposure **and** contamination are primary radiological concerns

Committed Dose Equivalent (CDE):	1080 mrem/uCi (inhalation / thyroid)
(Organ Doses)	1761 mrem/uCi (ingested / thyroid)
	1776 mrem/uCi (puncture / thyroid)
	0.45 mrem/uCi (ingested / breast)

Annual Limit on Intake (ALI):
Ingestion:

- 30 uCi (all compounds / CDE / 50 rems to Thyroid)
- 90 uCi (all compounds / CEDE / 5 rems to Whole Body)

[1.0 ALI = 90 uCi ingested = 5,000 mrem CEDE (Whole Body)]

Inhalation:

- 50 uCi (all compounds / Class D / CDE / 50 rems to Thyroid)
- 200 uCi (all compounds / Class D / CEDE / 5 rems to Whole Body)

[1.0 ALI = 200 uCi inhaled = 5,000 mrem CEDE (Whole Body) = 2,000 DAC-hrs]

SKIN CONTAMINATION (I-131):

Skin Contamination Beta Dose Rate: 4,769 mrem/hour per 1.0 uCi/cm^2

* [Localized dose to basal cells at 7 mg/cm^2 or 0.007 cm depth in tissue without air reflection]

Skin Contamination Beta Dose Rate (Extremity): 1,182 mrem/hour per 1.0 uCi/cm^2

* [Localized dose to extremity skin at 30-50 mg/cm^2 or 0.03-0.05 cm depth without air refletion]

Skin Contamination Gamma Dose Rate: 61 millirem/hour per uCi/cm^2

NOTE: Skin dose assessments must account for gamma dose to the skin as well as beta dose even though the gamma contribution will be small compared to beta dose.

- Thyroid accumulates 30% of soluble radioiodine in the body. The % uptake for adults and children are similar.

- Inhaled radioiodine reaches equilibrium with body fluids in about 30-minutes.

SHIELDING

Half-Value Layer (HVL / Lead): 0.09 inch = 0.23 cm
Tenth-Value Layer (TVL / Lead): 0.28 inch = 0.70 cm
Half-Value Layer (HVL / Water or Tissue) 2.50 inch = 6.30 cm

* Half-Value Layer (HVL) is the thickness of any given absorber or shield that will reduce the intensity of a radiation beam to 1/2 (50%) of its initial value.
* Tenth-Value Layer (TVL) is the thickness that will reduce the intensity of a radiation beam to 1/10 (10%) of its initial value.

*NOTE - Plexiglass, acrylic, plastic, wood, or other low-density material will **NOT** shield I-131 gamma; use lead bricks.*

EXPOSURE RATES: From an unshielded 1.0 millicurie isotropic point source I-131.

Distance	mR/hour
1.00 cm	2200.00
10.00 cm	22.00
6.00 in	9.50
100.00 cm	0.22

SURVEY INSTRUMENTATION:

- Use a survey meter and, preferably, a G-M pancake/frisker (15.5 cm^2 surface area) probe to detect I-131 contamination. G-M pancake/frisker probe efficiency for I-131 is ~ 8%.

- Use a survey meter and a NaI scintillation probe to obtain highest sensitivity and counting efficiency; however, a G-M survey meter is adequate and most cost-effective for I-131 laboratory work.

- Liquid scintillation counter (indirect counting) should be used to detect removable I-131 contamination on smears or swabs.

PERSONAL RADIATION MONITORING DOSIMETERS (Whole Body and Finger Tabs): **REQUIRED** when handling > 5 mCi of I-131 at **any** time.

THYROID BIOASSAY: **REQUIRED** after working with > 1.0 mCi of I-131 on an open bench top or > 10.0 mCi in an exhaust hood. Contact RSS (764-6200) for thyroid count.

- For a continuous inhalation exposure rate of 1/365 of an ALI per day, the following equilibrium are attained:

  * Thyroid Activity: 0.262 uCi (Class "D" / Inhalation)
  * Daily Urinary Excretion Rate: 0.054 uCi / day

REGULATORY COMPLIANCE LIMITS (10 CFR 20 / Appendix B)

- Derived Air Concentration (DAC): 2.0E-8 uCi/mL (all compounds)

- Airborne Effluent Release Limit:* 2.0E-10 uCi/mL (all compounds)
  (Annual Average)

  * Applicable to the assessment & control of dose to the public (10 CFR 20.1302). If this concentration was inhaled or ingested continuously over one year it would produce a TEDE of 50 millirem.

- Urinalysis: Not Required; however, may be requested by RSS/EHS after an I-131 spill or suspected intake.

- Unrestricted Area Removable Contamination Limit: 200 dpm / 100 cm^2

- Container Labeling Requirement [10 CFR 20.1905]: $\geq$ 1 uCi

GENERAL RADIOLOGICAL SAFETY INFORMATION

- Inherent Volatility (STP): **SIGNIFICANT** [volatilization is a very significant concern with I-131 especially in a disassociated (free) form or acidic solutions]

- Acidic and frozen solutions enhance radioiodine volatility.

- Store at room temperature: DO NOT FREEZE (whenever possible)

- Radioiodine labeled compounds should be assumed to be potentially volatile because decomposition can give rise to free iodine in solution. Maintaining radioiodine solutions at low (dilute) concentration minimizes radiolytic decomposition.

- Soluble iodide ion is oxidized to elemental (free) iodine that has low solubility in water and a high vapor pressure. Acidic solutions enhance the oxidation of sodium iodide to elemental (free) iodine; thereby, increasing volatility.

- Regulatory limits on personal intakes and environmental releases of I-131 are quite restricted because of the relatively high radiotoxicity relative to other common university-related radionuclides.

- Urine bioassays should be conducted approximately 24-hours after a suspected intake of I-131.

- Thyroid bioassays conducted by Radiation Safety Service (RSS) personnel **must** be conducted after handling > 1.0 mCi of free or unbound (NaI) form of I-131 on a bench top or > 10.0 mCi in an exhaust hood. Contact RSS/EHS (764-6200) for a thyroid count.

- Addition of antioxidants (sodium thiosulfate) to either labeled or sodium iodine solutions of I-131 will help reduce both decomposition and volatilization. Alkaline sodium thiosulfate should be used to chemically stabilize I-131 prior to initiating decontamination of an I-131 spill (0.1 M NaI, 0.1 M NaOH, and 0.1 $Na_2S_2O_3$).

- Drying can form airborne I-131 contamination.

- Radioiodine in the body is eliminated quite rapidly via the urine.

- Most radioiodine accidents are in a soluble form and will be rapidly absorbed via inhalation, ingestion, absorption through the skin, or any combination of these routes.

- Due to its volatile character and ease of absorption, potentially exposed individuals should be monitored after any accident or spill either by in-vivo (thyroid count) or in-vitro (urine) analysis.

- Thyroid counts made within 12-hours after a suspected intake of I-131 often may be unreliable due to skin contamination.

- Of the iodine entering the transfer compartment of the body, approximately 30% is taken up by the thyroid and the remainder (70%) is assumed to be excreted in the urine (ICRP 54).

- Iodine is lost from the thyroid in the form of organic iodine. This organic iodine uniformly distributes among all organs & tissues of the body, other than the thyroid, and is retained with a biological half-life of 12 days. 90% of the organic iodine lost from the thyroid is returned to the transfer compartment and the rest is excreted via the feces.

- The administration of stable iodine (KI or Lugals Solution) blocks the transfer of radioiodine to the thyroid. The onset of inhibition (thyroid blocking) occurs rapidly after administration of stable iodine.

  NOTE: The use of stable iodine blocking agents is a <u>personal</u> choice. RSS / EHS will **NOT** recommend the use of such blocking agents due to any potential personal side effect from such agents.

- The urinary excretion rate decreases by more than two orders of magnitude within 5 days after intake. Thus, uncertainties in interpretation of urinary excretion that arise because of the unknown time of intake in routine monitoring may be large unless exposure is avoided for 5 days before sampling.

- Expelling I-131 solutions through syringe needles and pipette tips can generate airborne aerosols.

- **Always** wear a lab coat and disposable gloves (preferably, two pairs) when handling I-131.

- Monitor hands, lab coat, shoes, work areas, and floors using a G-M survey meter equipped with a pancake/frisker probe for gross contamination.

- Monitor for removable surface contamination by smearing, swiping, swabbing, or wipe testing where I-131 is used. Count smears or swabs in a liquid scintillation counter (LSC), gamma counter, or gas proportional counter (GPC).

IODINATION PROCEDURES

- Iodinations **must** be conducted in an RSS/EHS-approved exhaust hood.

- Iodinations **must** only be conducted using an RSS/EHS-approved "closed" system (no pipetting & no open containers during iodination process). Only use rubber-septum sealed vials or containers and syringes.

- A RSS/EHS health physicist must observe initial cold and hot iodination runs.

- Thyroid bioassays are **required** after using > 1.0 mCi of I-131 on an open bench or iodinating with > 10 mCi in an exhaust hood (Byproduct Material License / Regulatory Guide 8.20).

- Whenever possible, perform iodination reactions in the original sealed shipping vial when handling potentially volatile radioiodine.

- Vent the airspace of stock and reaction vials through an activated charcoal-filled syringe trap during iodination procedures.

- Remove potentially contaminated syringe needles from stock a reaction vials through absorbent material (tissue paper, cotton, etc.).

- Store I-131 contaminated objects (syringes, stock vials, waste, etc.) in sealed containers (zip-lock bags, plastic containers, etc.).

- A solution of sodium thiosulfate should be on-hand during iodination procedures.

- Obtain iodination safety protocols from RSS/EHS.