RP GN009 – SAFE WORKING WITH IODINE-131

VERSION CONTROL	
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Risk

Iodine-131 is a beta and gamma emitter. The energies of both are significant, so quite high dose rates are emitted by this nuclide, and the gamma radiation is quite penetrating. The half-life is 8 days, so over the likely period of use of the material, there is not a large reduction in activity. There can therefore be an external radiation risk in the use of this nuclide.

Iodine-131 will also present a risk if it gains entry to the body. It can be inhaled, ingested and absorbed. The thyroid holds 70% - 80% of the body's iodine content, and so it is the thyroid that is the critical organ for radioiodine uptake. Its biological half-life varies according to the compound to which it is attached, but the effective half-life is around a few days (ICRP 94, "Release of Patients after Therapy with Unsealed Radionuclides", March 2004). Iodine compounds can be volatile, and precautions are required to reduce the risk of inhalation in certain circumstances.

Special Considerations

- There is a need to shield against both the beta and the gamma radiation. The beta radiation should be shielded by low atomic-number and density material, such as plastic, and dispensing of stock materials should be performed behind at least a 2 mm thick acrylic screen. To avoid the generation of bremsstrahlung, the low atomic-number/density material should be the first in contact with the radionuclide.
- Secondary, high-density, material should be used for shielding against the gamma radiation. Such shielding should be used for the storage of I-131, but during the handling of the material substantial shielding is often impractical, and protection against external radiation might have to predominantly be by time and distance. Normal x-ray lead aprons will not provide any significant shielding; a 0.35 mm Pb apron would reduce the radiation level by about 8%.
- The volatility of iodine must be considered. Solutions containing iodide ions should not be made acidic nor stored frozen, as both these procedures lead to the formation of volatile elemental iodine. It is preferable that the correct quantity of radioiodine is acquired for a particular use; stock solutions should not be left for long period of times.

Radioiodinations must be carried out in a fume cupboard or in the presence of suitable local extract ventilation.
- Because some compounds of iodine can penetrate gloves, two pairs should be worn when handling unsealed radioiodine, changing the outer pair frequently.

Monitoring

- Field contamination monitors should be used that are capable of detecting the beta radiation. Contamination therefore can normally be detected by end-window geiger-muller tubes, such as the Mini E. Sources must be removed or shielded whilst monitoring for contamination. Further information is available in Guidance Note GN003 and from the Radiation Protection Unit.
- Conventional personal dosemeters are suitable for the external radiation from I-131. Extremity dosemeters should be worn by those injecting the material. The need for any personal monitoring is reported in the relevant Proposed Scheme of Work form.
- Monitoring for uptake should need only be normally considered after a suspected or known uptake. However, if radioiodinations are being carried out, measurements can be made of the uptake of iodine to the thyroid by the use of a sensitive gamma scintillation counter. These should be undertaken only after consultation with the RPU.

Physical Data and properties

Decay Data	
Half life ($t_{½}$)	8.04 days
Decay constant (λ)	0.0866 d^{-1}
Daughter product	Stable (Xe-131, although 0.7 % decays to the radioactive daughter Xe-131m)

Emissions	**Max. Energy**	**Abundance**
Beta emission	606 keV other lower	87% 13%
Gamma emission	360 keV 640 keV 720 keV other lower	79% 9% 3% 9%
Dose rate from a point source of 1 GBq at 30 cm distance	gamma – 0.7 mSv/h beta – 86 mSv/h	

Transmission through materials [a]	**Air**	**Glass**	**Plastic**	
Maximum range of beta radiation (mm)	1650	0.9	1.6	
	1 mm thick	**10 mm thick**	**HVL**	**TVL**
Lead (γ radiation)	~0.77	~ 0.07	3 mm	11 mm
Steel (γ radiation)	~ 0.93	~ 0.48	23 mm	56 mm
Concrete (γ radiation)	-	~ 0.80	~ 30 mm	~ 100 mm

Biological Data	Annual Limit of Intake by inhalation [b]	Annual Limit of Intake by ingestion [b]
All compounds	1.8 MBq	0.9 MBq

Typical Dose Rate & Contamination Readings [c,d]	Mini E	Mini EP15
Background count rate (cps)	1	1
Count rate above bgnd equivalent to a γ dose rate of 1 µGy h^{-1} (cps)	~ 2.5	~ 6
Count rate above background for spot activity of 1 Bq (cps)	~ 0.2	~ 0.2
Count rate above background for a large area activity of 1 Bq cm^{-2} (cps)	~ 1.5	~ 3.5

Decay Table							
Days	% Remaining Activity	Days	% Remaining Activity	Days	% Remaining Activity	Days	% Remaining Activity
-8	199	6	59.4	18	21.0	30	7.4
-6	168	8	50.0	20	17.6	32	6.2
-4	141	10	42.0	22	14.8	34	5.2
-2	118	12	35.3	24	12.5	36	4.4
2	84.1	14	29.7	26	10.5	38	3.7
4	70.7	16	25.0	28	8.8	40	3.1

NOTES:

a) HVL – Half-value Layer – is the thickness of a material that will reduce the dose rate to half of its original value, and TVL – Tenth-value Layer – is the thickness that will reduce it by a factor of ten. The values for lead and steel, along with the beta transmission data, are obtained from standard references; the values reported for steel are actually those for iron. The remaining values are calculated, using reference attenuation coefficient data for 400 keV photons. The values reported for concrete are for a density of 2.3 t m^{-3}.

b) The Annual Limit of Intake represents the activity which, if taken into the body, would lead to a committed effective dose equal to the occupational annual dose limit for the whole body for classified workers of 20 mSv. This value would have to be reduced if there is any other source of occupational exposure. Where there are inhalation values for different particle sizes, the most restrictive is quoted here.

c) Dose-rate readings should be undertaken with an instrument scaled in dose-rate units and using a compensated GM detector or ion chamber. The values in the table are for instruments that could be used as a backup if a dose-rate meter is not available.

d) Contamination readings are quoted for a probe-to-source distance of 10 mm.

For advice on any of the above topics please contact the Radiation Protection Unit, radiation@ed.ac.uk.