THE USE OF INDIUM-111

Indium-111 is an electron capture nuclide ie it does not emit a beta particle but instead captures one of the orbital electrons (usually the K electron) in the indium atom. Following the capture of this electron, the resulting cadmium nucleus is left in an excited state and immediately rids itself of this excess energy by emitting gamma ray photons of energy l7l and 245 keV. As well as this gamma radiation, X-Ray photons of energy approximately 23 keV are emitted, these result from the de-excitation of the daughter cadmium atom. In a small percentage of disintegrations the cadmium-111 nucleus uses its excess energy to eject an orbital electron from the atom - this is called an internal conversion electron and it emerges from the atom with kinetic energy equal to the original energy of the photon minus the binding energy of the electron in the atom.

Summarising the properties of indium-111 we have:

Nuclide	Half-Life	Type of Decay	Gamma Ray Energies & % abundance	% Internal Conversion	Energy of Conversion Electron	Energy of X-Ray Photons & abundance
^{111}In	2.83 days	Electron Capture (l00%)	0.l7lMeV (90%) 0.245MeV (94%)	l0% 6%	0.l44MeV 0.218MeV	23 keV (95%)

An end window geiger-muller tube eg Minimonitor Type E, Type EL or Type EP15 will detect the emitted internal conversion electrons, but notice that only l6% of the indium-111 disintegrations produce a conversion electron, so the detection efficiency is correspondingly reduced. These monitors are relatively insensitive to the X and gamma radiation detecting only about one photon in a hundred.

The scintillation counter minimonitor Type 42B usually used for monitoring iodine-125 is equally suitable for monitoring indium-111 since it has almost l00% efficiency for detecting the 23 keV X-radiation. It also detects the gamma ray photons but with a reduced efficiency since the scintillator in this monitor (NaI (TI)) is only lmm thick. A contamination level of 3Bq cm^{-2} will produce a count rate of 2cps above background on the Type 42B.

The GM Minimonitor Type E may be used to obtain a crude estimate of the dose rate from the X and gamma radiation by using the conversion

1 µSv h^{-1} = 2.4 cps
ie Adequate Shielding Level (7.5µSv h^{-1}) = l8 cps

The calculated dose rate at a distance of lm from l MBq of indium-111 is 0.054 µSv h^{-1} from the gamma radiation and an additional 0.080 µSv h^{-1} from the X-radiation, ie a total dose rate of 0.13 µSv h^{-1} at lm from l MBq.

So a millicurie (37 MBq) of In-111 will produce a dose rate of 5 µSv h^{-1} at a distance of lm.

The X-radiation is easily stopped by lead foil of thickness 0.5 mm, but the gamma radiation requires 4mm of lead to attenuate the dose rate by a factor of x l00.

Due to its relatively short half-life (2.83 days), the Annual Limit of Intake to produce an effective dose of 20 mSv is quite large.

ALI (ingestion)	:-	5 x $l0^7$ Bq
ALI (inhalation)	:-	9 x 10^7 Bq

Further information on the use of this radioisotope can be obtained from the University Radiation Protection Service ext 4471.