Appendix 4. Dose estimation

A4.1 Calculation of exposure to β-radiation sources

The amount of exposure 10cm (0.1m) from a point source of unshielded β-emitter can be calculated to a reasonable approximation by the equation:

Dose (μSv/h) = 800 x Activity (MBq)

However, remember that the inverse square law applies and so, for example, considering 1μl of 10MBq of ^{32}P spilt on to a gloved hand 1mm from the skin, then:

Dose rate at 10cm = 800 x 10 = 8 mSv/

Dose rate at 0.1 cm = 8 x $(10^2/0.1^2)$ = 80Sv/h

Hence it can be seen that even a small spill of ^{32}P can give a very high dose to the skin and it has been known for people to suffer from radiation burns to the skin through the careless handling of ^{32}P. These betas can transverse 7-8 meters of air.

Note that the equation for calculation of exposure does not consider the energy of the particle, that is, it is assumed that all particles reach and penetrate the tissue. In the case of tritium, the betas are absorbed by air and gloves and in any case cannot penetrate the dead layer of the skin. Tritium is an internal hazard only. In the case of the isotope ^{14}C the β particles are generally absorbed by air and gloves before the particles can reach the skin and so the external hazard is very low. A 0.3mm of plastic, or 20-30cm of air can stop all betas from ^{14}C.

A4.2 Calculation of dose from γ sources and electron capture (EC) radionuclides

The dose rates from point sources of these types of radioisotopes can also be calculated. In this case the dose rate for each energy of γ radiation is:

$$\text{Dose rate } (\mu Sv/h) = \frac{\text{Activity(MBq) x Energy(MeV) x Fraction of total radiation}}{7 \times (\text{Distance(m)})^2}$$

It is necessary to sum the exposure from each energy band to get the total exposure

Currently there are very few people using γ-emitting isotopes on campus and the most widely used EC radioisotope is ^{125}I. In the case of ^{125}I then the dose rate at 10cm from a 10MBq point source of ^{125}I is 140μSv/h; that is if spilt on a glove then the skin beneath would receive 1.4Sv/h.

A4.3 Assessment of internal contamination

If an isotope such as ^{125}I is ingested then an estimate of the total ingested and the whole body exposure can be obtained through thyroid scanning or whole body scanning at the local hospital. Similarly it is possible to check for high levels of ^{32}P ingestion using these methods. However, usually the method used for most isotopes is to check the urine for the presence of radioactivity since all labelled compounds will undergo some degree of breakdown followed by excretion. The retention in the body will depend on the type of radioisotope and the nature of the compound into which it has been incorporated. Typically, in the case of thymidine and uridine as much as 90% of the radioactivity will be incorporated into nucleic acids and about the same amount of methionine is incorporated into proteins. Note that radioactivity incorporated into DNA is much more stable (and dangerous) than that incorporated into RNA and protein.