Radiation Safety Unit

General Awareness Information on Ionising Radiations

This document has been prepared to inform university staff of (i) the nature and biological effects of ionising radiation, and (ii) generic procedures for the working safely in areas where sources of ionising radiation may be located.

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- **What is ionising radiation?**

Ionising radiation is the term used to describe electromagnetic waves or electrically-charged, subatomic particles that derive from decay of the unstable atomic nuclei of a number of naturally-occurring or man-made elements (radioisotopes). It can also be generated artificially, as in X-ray machines.

It is important to recognise that, even if your own work does not involve the use of ionising radiation, you will always be exposed to “background” radiation, deriving from natural sources which include rocks and building materials (e.g. bricks, sand and gravel). Low levels of radioactivity may also be deposited in the body as a result of ingesting certain foodstuffs. Exposure to cosmic rays, as a further form of naturally-occurring radiation, increases dramatically with altitude such that frequent long-distance air travel may constitute a significant fraction of your “background” radiation dose. The annual dose of radiation that you are liable to receive also includes a component resulting from medical investigations, typically in the form of diagnostic dental X-rays.

At the level normally encountered, the “background” ionising radiation that you receive from natural and artificial sources should not be the cause of any concern. However, inadvertent exposure to higher levels, or long-term exposure to lower levels could result in damage to body tissues; one of the fundamental objectives of Radiological Protection is to reduce the risk of such damage, through minimising the dose of ionising radiation received, so far as is reasonably practicable.

- **How do I know if my work will put me at risk of exposure to ionising radiation?**

Various forms of naturally-occurring and artificially-generated radioactive material are used for research purposes in the university, principally in the Faculty of Life Sciences and the Schools of Medicine, Pharmacy, Physics and Astronomy, Chemistry and Earth Sciences.

In the School of Physics and Astronomy, radioactive materials are in the form of **sealed sources**, i.e. they are encapsulated within a coating of an inert material, typically glass or steel. In all other Schools, the sources in use are **unsealed**, primarily in the form of liquids, but also as powders.

All university Schools in which radioactive materials are handled or stored will have one or more appointed Radiation Protection Supervisors (RPSs), who are required to ensure that all sources of ionising radiation are handled, stored and disposed of safely, in accordance with national legislation and the university Health and Safety Policy.

The Head of School, and NOT the RPS, is responsible for ensuring the safety of individuals entering or working in areas where radioactive sources may be present.

The locations on the university campus where radioactive materials are present are required, by Law, to be clearly identifiable, as depicted in **Figures 1 and 2**; you should be in no doubt that you are entering such an area.

Figure 1

Figure 2

In areas or rooms where the sign shown in Figure 2 is displayed, higher levels of radiation may be encountered in Supervised Areas (Figure 1), because of the nature of the work authorised to be undertaken there. The maximum activities and working arrangements will have been strictly defined and Risk-assessed so as to ensure that the maximum radiation dose that may be received in that area remains within statutory limits.

If you need to enter a room displaying either of the signs depicted in Figures 1 or 2, you **MUST** contact the RPS for that area who will issue you with specific instructions; the name and contact details of the individual concerned will be clearly shown on the label.

- **Why is it important that I keep my exposure to ionising radiation as low as possible?**

While radiation hazards can arise from exposure of the body to external radiation, they can also arise from inadvertent ingestion or inhalation of radioactive substances. If taken into the body, a radioactive substance will irradiate the tissues until either the radioactivity has decayed or the substance has been excreted. When body tissue is exposed to ionising radiation, energy is imparted to the component cells, and critical molecules therein may suffer ionisation damage. Furthermore, if the genetic material (e.g. DNA) of susceptible cells is damaged by ionisation, then there is an increased risk of tumour formation or heritable mutations in the DNA which may be transmitted to one's future offspring.

Two fundamentally different forms of radiation-induced damage have been identified. So-called **deterministic effects** include short-term localised damage, the most common example of which is a radiation burn. This ranges from reddening of the skin, persisting for a few days, to more serious effects including ulceration or blistering. Hair loss and cataract formation are further examples. Those tissues containing rapidly-dividing cells (e.g. bone marrow and the gut lining) are more susceptible to damage by radiation exposure, with serious consequences. Deterministic effects of radiation are dependent upon threshold doses of radiation being exceeded; below those doses, they will not occur. Although the dose of radiation typically received by university radiation workers is far below the threshold levels for deterministic effects, the imposition of a statutory **dose limit**, together with locally-imposed **dose constraints** ensures that such effects are prevented.

While the imposition of a statutory radiation dose limit offers protection against deterministic effects, a further type of tissue damage may occur even in the *absence* of occupational radiation. These are termed **stochastic effects**, and exposure to ionising radiation increases the *probability* of such an effect occurring. Thus even low radiation doses, cumulatively received over a long period may be harmful, and may lead to tumours of the skin, lungs and digestive tract, and damage to the reproductive (germ) cells.

- **How can I ensure that I minimise the dose of ionising radiation that I receive in the course of my work?**

(i) If your work involves the deliberate use of ionising radiation sources, all manipulations involving such sources must be subject to a formal and prior Risk Assessment(s) to establish the precise working conditions and procedures consistent with minimal risks from radiation exposure. The assessment will also have determined the likelihood of any accident, its consequences, and established a Contingency plan for the necessary actions. For example, where a risk of exposure is deemed to be significant (e.g. work with radioactive dust), a Risk Assessment would establish a requirement for the work to be undertaken in a negative-pressure glove box. For operations deemed to be less hazardous, a lower degree of containment (an efficient fume cupboard) might be acceptable. Procedures requiring only minimal containment might typically be carried out on lined trays in a laboratory with non-porous bench-tops and sealed flooring.

In general, the external radiation hazard from radioactive sources may be reduced by (i) minimising the activity used; (ii) minimising the handling time; (iii) maximising your

distance from the source, and (iv) providing adequate shielding of the source. The underlying principle is that a Risk Assessment should identify appropriate measures to reduce the risk to an acceptable level; the findings must then be implemented and periodically reviewed.

While an inadvertent radiation dose could be received from either a sealed or an unsealed source, an accidental or unchecked spillage of the latter could also contaminate work-surfaces and floors, leading to ingestion of radioactive material and consequential internal irradiation of the body tissues. Where such sources are present therefore, it is vitally important to control contamination levels through regular and systematic monitoring. In general, the likelihood of contamination will be minimised by (i) segregating radioactive and non-radioactive work, (ii) careful containment measures, and (iii) using personal protective equipment. The appropriate levels of segregation, containment and personal protection should be determined by formal Risk Assessment, and must be clearly defined in the relevant Local Rules; these must be consulted before you commence any manipulations with sources of ionising radiation.

(ii) If your work does not involve the deliberate use of ionising radiation sources, but you need to enter an area where such sources are used or stored, you should contact the RPS for directions regarding entry requirements and restrictions, use of protective clothing, etc. You must not eat, drink, smoke, apply cosmetics or chew gum in any area designated for work with radioactive materials.

In areas where open radioactive sources are used, you may encounter a laboratory sink bearing the sign shown in **Figure 3**. You must not use this sink for hand washing. Also, you should not touch or handle any item bearing the warning sign shown in **Figure 4**.

Figure 3

Figure 4

If you have any doubt whatsoever regarding your safety in any area of the university where ionising radiation may be encountered, you should seek advice from area or School RPS, or if not available, a senior member of the laboratory staff.

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