WHS Guidelines – Use and handling of ionising radiation.

1. Scope

This document applies to all areas in the School of Physics where ionising radiation sources are used or stored. The purpose of this document is to provide details of minimum requirements for using and storing radiation sources and to provide information to assist personnel when conducting risk assessments and developing proper and safe procedures and appropriate documentation. The ionising radiation sources refer to sealed and unsealed sources, and irradiating apparatus.

2. Introduction

In the School of Physics, ionising radiation sources are usually sealed sources, however, there are occasions where unsealed sources may be used, which require greater care in handling procedures than the sealed sources since there is the potential for them to spread into the immediate environment or be ingested. Other sources of ionising radiation are high voltage machines that can produce an electrical discharge, which may result in the production of x-rays. This may be intentional, such as in an x-ray generator for materials testing, or may be accidental such as machines that produce a gaseous electrical discharge. In the latter, x-rays may leak out of the apparatus and irradiate the operator.

When conducting risk management activities, people with WHS responsibility should:

- Ensure that minimum requirements are in place
- Use their expertise and the hazard summary table below identify any hazards in the environment and implement appropriate mitigation strategies

3. Definitions

- **Ionising radiation** means energetic particles that have sufficient energy to remove an electron from an atom or molecule. The energetic particles may be photons, electrons and atomic nuclei.
- **Sealed source** means the radioactive material is encapsulated inside a solid so that it is always contained within that solid.
- **Unsealed source** means an uncontained source such as a radioactive chemical.
- **Irradiating apparatus** means an electrical device that can produce x-rays.

4. Minimum Requirements

- All sealed and unsealed sources must be clearly labeled or the equipment containing the source must be labeled.
- The activity of both sealed and unsealed sources must be within the limits set out in the School license to possess radioactive sources.
- Loss or theft of closed sources must be reported to the School's radiation and safety officers.
- Arrange for the safe storage of radioactive materials and for the safe disposal of any radioactive waste in accordance with University procedures.
- When not in use, radioactive sources must be stored in an area inaccessible to staff or students that do not use these sources.
- Maintain a record of the type, activity and location of radioactive sources with the School's radiation officer.
- All new high voltage (greater than 10 kV) gaseous discharge or electron beam devices are monitored for x-ray leakage and steps taken to stop or reduce any x-ray leakage.
- Radiation dose badges or personal radiation monitors are required for staff that regularly use radioactive or irradiation apparatus.
- All radioactive sources and their storage containers, and radiation producing machines are to be labelled with the radiation symbol.
- Always keep the exposure to radiation as low as reasonably achievable (ALARA).

5. Hazard Summary Table

Hazard	**Possible consequences**	**Mitigation Options**
Exposure	Long term Cancer risk	– Minimize exposure time – Maximize distance from the source – Use shielding whenever possible – Use personal radiation monitors
Ingestion of unsealed sources	Poisoning and cancer risk	– Wear a lab coat, gloves, goggles – Use a fume cupboard

6. Hazard Description

Radiation causes ionizations in the molecules of living cells. These ionizations result in the removal of electrons from the atoms, forming ions or charged atoms. The ions formed can go on to react with other atoms in the cell, causing damage. An example of this would be if a gamma ray passes through a cell, the water molecules near the DNA might be ionized and the ions might react with the DNA causing it to break.

At low doses, such as from every day from background radiation (about 1 milliSievert per year), the cells repair the damage rapidly. At higher doses (up to 3 Sieverts), the cells might not be able to repair the damage, and the cells may either be changed permanently or die. Most cells that die are of little consequence, the body can just replace them. Cells changed permanently may go on to produce abnormal cells when they divide. In the right circumstance, these cells may become cancerous. This is the origin of our increased risk in cancer, as a result of radiation exposure.

(a) The dose accumulated by a person is directly proportional to the amount of time they spend in the radiation area.   Dose = Dose Rate x Time

- The less time spent in a radiation environment, the smaller is the radiation dose.
- Plan the work to avoid unnecessary exposure. If necessary, a dose rate measurement or estimate can be made and a time limitation set for the work undertaken.
- The greater the distance from a source of radiation the smaller is the radiation dose. Thus if you double the distance from a source, the dose rate decreases by a factor of four.
- Use tongs or tweezers whenever practical to handle radiation sources, and spend the least time possible doing so.

Shielding is the practice of placing an attenuating medium between the source of ionising radiation and the worker. The attenuating medium, or shield, then minimises the radiation that would ordinarily reach the worker. The type and amount of shielding required depends on the type and energy of radiation emitted and its intensity. If shielding is to work effectively it must be properly designed and made from materials of the appropriate density. Dense (high atomic number) materials (e.g. lead and depleted uranium) make the most effective shields for highly penetrating radiation such as gamma radiation. For lesser penetrating radiation such as beta particles low atomic number materials can be used (e.g. Perspex or aluminium). X-rays produced in high voltage machines can be shielded with the same material as those used for the higher energy gamma rays, but the thickness of the material may be less due to the lower energy of the x-rays.

(b)

Intake through ingestion of unsealed sources can be minimized by ensuring that potentially contaminated objects are not placed in the mouth. In areas where unsealed radioactive materials are handled, do not eat, drink, smoke, apply cosmetics, pipette by mouth or place fingers, pens and pencils in your mouth. Physical barriers can prevent accidental ingestion due to explosion or splashing. Inhalation intakes can be prevented by ensuring that radioactive materials are secured in sealed containers. When sealed systems are impractical or additional precautions are necessary, radioactive materials that could become airborne should be handled in ventilated enclosures, such as fume cupboards. Fume cupboards provide protection by drawing air past the worker into an enclosure and safely exhausting it. In this process, small releases are diluted to negligible concentrations by the air flow.

7. General

It is the primary responsibility of the Local Radiation Safety Officer to be the liaison officer between users of radiation in their areas and the University Radiation Safety Officer and the Radiation Safety Committee.

It is recommended that the Local Radiation Safety Officer be responsible for the following key tasks:

- Allocation and collection of personal radiation monitors.
- Assisting with radiation licensing issues.
- Identifying local radiation risk areas.
- Monitoring radioactive waste disposal.
- Authorising the purchases of radioactive materials or radiation apparatus before an order is placed.