Safe Use of Diagnostic X-ray Equipment
General Awareness
What are X-rays and why are they dangerous?

- X-rays are a form of light, similar in nature to visible light

- The main difference between them is that X-rays have a much shorter wavelength and consequently higher energy than visible light. The human eye cannot see these wavelengths and so X-rays are invisible to the human eye.
• X-rays are called ‘penetrating radiation’ as they can pass through the skin and deep into the body. Check out the you tube link below to see how X-rays work

https://www.youtube.com/watch?v=hTz_rGP4v9Y

• It is the penetrating properties of X-rays that make them useful in diagnostic imaging in both the medical and veterinary fields.

• In typical diagnostic imaging X-ray systems the voltage of the X-ray tube is in the range 50 kV to 150 kV. The voltage and current in the X-ray tube is determined by trained radiographers to give the best image possible whilst minimising the radiation dose to the patient.

• In CT (or Computerised Tomography) systems, a computer rotates an X-ray tube around the patient to give a 3-d image of the area under investigation.
Why are X-rays dangerous?

- X-rays are a type of Ionising Radiation and as such can cause damage to a biological system.

- Damage caused by ionising radiation is not immediately apparent and can take up to several years to become known.

- Damage to a body happens at the cellular level and can either happen directly, causing cell death or damage to DNA/RNA in the body. Or damage can happen indirectly by the creation of free radicals within the body.

- The amount of damage caused to the body is measured by the dose received by the body. The dose reported to staff from their dosimeters is called the effective dose, which takes into account the type of radiation and the organ with most exposure. The units are Sieverts.

- For radiation workers; the annual dose limits from IRR17 are:
  - Whole body dose – 20 mSv average over 5 yrs
  - Eye – 20 mSv
  - Skin - 500 mSv
  - Public/non-radiation worker – 1 mSv
Damage to the body caused by ionising radiation is categorised in two ways:

1. **Deterministic** effects: these are effects which will occur above a certain threshold value – e.g. below a dose of 250 mSv, there will be no observable effects. Above the threshold the severity increases with increasing dose.

2. Other specific effects such as Radiation Induced Cataract and Skin Burn.
• Stochastic Effects: these are effects whereby we say there is a *probability* of an effect. Currently a linear no threshold approach is used, with the latest guidelines being a 5% probability per Sievert of a cancer being developed later in life.
How to reduce the hazard

Administrative Controls

Knowledge Practical Training

Record Keeping

So you do keep a log of where things are buried!!

Local Rules & Risk Assessment

RADIATION PROTECTION SERVICE

LOCAL RULES

These local rules relate to the following activities:

1. Collection of low level radioactive waste from departments of the University using unsealed radioactive materials
2. Annual testing of contamination monitors
3. Receipt and delivery of isotopes from courier to end user
4. Annual wipe testing of sealed sources.
5. Source removal from counters.
6. Departmental Surveys

X-rays:
How to reduce the hazard

Administrative Controls

- *Dose limits and the issue of dosimeters;*
  - The university has set an investigation level of 1/10 the IRR17 limits and will investigate any recorded breach of the limits.

- *Risk assessments;* each procedure using ionising radiation must have a risk assessment.

- *Local Rules;* take the information from the risk assessment and detail a safe working practice for each procedure.

- *Trained operators* - only those trained in the use of the equipment by qualified radiographers are allowed to operate X-ray devices.

- *Awareness training* – hazards associated with ionising radiations
How to reduce the hazard

Administrative Personnel

• Local Radiation Protection Supervisor (LRPS) – every building must have an LRPS (IRR17) and one or more deputies. The LRPS ensures that the use of X-rays is carried out in accordance with the Local Rules and appropriate Risk Assessment. Other duties include, registration of new workers, organising appropriate training, contractor handover and liaise with the Radiation Protection Adviser (RPA).

• Trained operators – operation of X-ray systems should only be carried out by a trained operator, either a qualified radiographer or those trained by a qualified radiographer.
Radiation Protection Service
University of Glasgow

X-rays:

How to reduce the hazard

Engineering Controls

Mobile Vet X-Ray

Cell Irradiator
How to reduce the hazard

**Engineering Controls**

- All manufacturers must install safety systems into their equipment.
  - Trigger mechanisms
  - Shielding
  - Variable apertures
  - Remote switches
  - Warning lights on the device
  - Positioning lasers (low power)
- Additional controls may be put in place by School/College
  - Designated Areas
  - Warning signs/lights
  - Fixed shielded areas
How to reduce the hazard

Personal Protective Equipment - PPE
How to reduce the hazard

Practical Measures

• Time – minimise time spent in the radiation field
• Distance – maximise the distance between yourself and the radiation source, radiation obeys the ‘inverse distance law’. Double the distance reduces the dose rate by 4
• Shielding – use effective shielding when available - aprons, gloves, thyroid guards, hats as appropriate. For diagnostic imaging the leaded equivalent should be 0.25 – 0.35 mm lead.
• Wear dosimeter, if provided
Remember - Minimise the Exposure -TDS

Time – dose received = dose rate x time

Distance – double the distance, quarter the dose
dose $\alpha \frac{1}{d^2}$

Shielding – shield as close to source as possible using mobile shield
if not possible use leaded apron, thyroid guard etc
Perspective

- Diagnostic X-rays can emit up to several hundred Sieverts per hour.
- $1 \text{ Sv} = 1000 \text{ mSv}$.
- Diagnostic units use triggering systems of a few milliseconds.
- Typical exposure from **primary beam** are in the order $0.2 - 2 \text{ mSv}$ per exposure.
- Typical exposure from **scattered radiation** are in the order $1 - 200 \text{ µSv/h}$ per exposure.
- Information from several years of U of G dose reports, indicate no staff receive $>2 \text{ mSv}$ per year (whole body dose)