Dr. Aseel K. Hussein
4th year lecture
Radiology

Radiation protection

Radioactivity: a natural & spontaneous process of radiating (emitting) excessive energy from unstable atoms of an element. This radiation will be either in form of particles or waves. The emitted particles or waves are called ionizing radiation because they have the ability to remove electrons from the atoms of any matter they interact with.

Elements that have different numbers of neutrons are called isotopes. Isotope is defined as the atom of the same element with different numbers of neutrons. Isotopes can be stable or unstable (example) the isotopes of Hydrogen: the hydrogen has one proton and one electron so it is stable isotope; Deuterium which has one proton, one electron and one neutron is still stable, whereas, the Tritium that isotope which contains one proton, two neutrons and one electron is unstable

Types of Radiation:

There are two types of radiation that may affect on the living tissue– particle and electromagnetic

1. **Particles:**
   a. β minus
   b. β plus
   c. α
2. **Electromagnetic waves:**
   a. γ – ray
   b. X – ray

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Penetrating distance of the radiation:

The penetrating distances of the radiation varies depend on the type of the radiation and people who are dealing with them can protect themselves if they considered these distances or even used the proper shielding type. For alpha radiation, four centimeters through the air can be enough to get rid of the radiation or using even a piece of paper will be enough for protection ourselves.

Beta radiation can pass several meters through the air, however; using plastic shield of around 0.8 cm is enough to protect the workers in this field.

For X-ray, shield of lead can minimally protect the workers from its danger while, Gamma ray is more penetrating than the x-ray so it is important to have a concrete for a perfect protection. The shielding types for each type of radiation is explained in (figure-1) below.

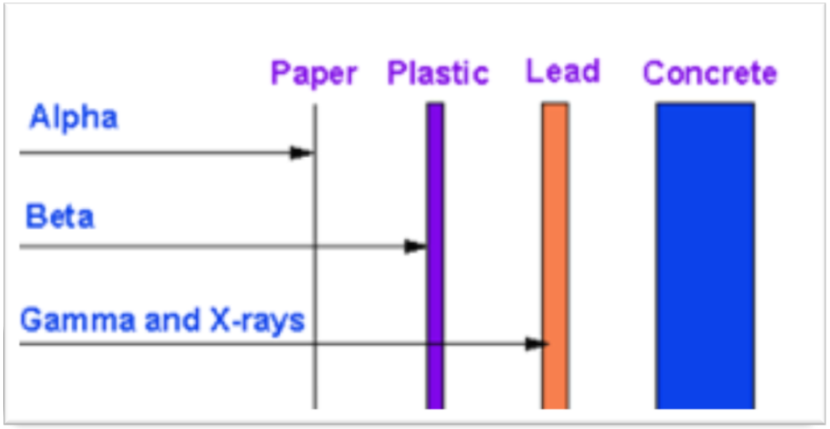

Figure 1: A figure shows the proper shielding for each radiation type to get rid of its hazard

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External Radiation Protection

Several points can be done to protect the interference people from the danger of radiation:

- **Time:** reducing the exposure type as shorter as possible will help reducing the type of exposing to the radiation them will help increasing the possibility of protection from radiation.
- **Distance:** Considering the standard distance to protect yourself from radiation
- **Shielding**
- **External Exposure Personnel Monitoring**
- **Posting and Labeling of Radioactive materials**

Internal Radiation Protection

- **Radioactive Materials in the Body**
- **Limits**
- **Internal Exposure Monitoring**

Detecting ionizing radiation:

In general detectors utilize one of the following principles:

- Ionization in gases
- Ionization in solids/liquids

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Types of devices for detecting radiation

1. Liquid scintillation counter: This type of the device used for counting the radiation that can be produce from the beta particle
2. Semiconductor Detectors: They are generally used for detecting Gamma and X-rays and are mainly two types a Silicon or Germanium
3. Personal Radiation Detectors (PRD) or Personal Monitoring: Small portable devices designed to give an instant reading. This type of detector is designed for the person him/herself to be curried by the workers in this field. It is included an alarm which can be set its level. This type of detectors is not totally accurate. There are types of this monitoring ex. Film badge and optically Stimulated Luminescence – OSL

Common isotopes that is used in the lab:

1. **3H:** 12.3 yrs, β- emitter , Cannot be detected using shielding < 0.1 mm plastic
2. **14C:** 5730 yrs, β- emitter. Shielding ~ 3 mm plastic
3. **32P:** 14.3 days, β- emitter, shielding ~ 6.3 mm plastic
4. **125I:** 60 days, X-ray emitter, shielding ~ 1 mm lead

The biological effect of the radiation:

In a biological system, ionization of a molecule can lead to direct or indirect damage to the system. This radiation has an effect on the whole body generally and

on specific structures faster than others ex. The lymphatic system and vascular system is affected faster by the radiation than the bony structures. The radiation hazard which is measured by Sievert (Sv) unit has exposure levels and symptoms:

- 0.05 - 0.2Sv: No symptoms
- 0.2 - 0.5Sv: No noticeable symptoms
- 0.5 - 1Sv: Mild radiation Sickness
- 1 - 2Sv: Light, 10% Fatality after 30 days
- 2 - 3Sv: Moderate, 35% fatality after 30 days
- 3 - 4Sv: Severe, 50% Fatality after 30 days
- 4 - 6Sv: Acute, 60% Fatality after 30 days
- 6 - 10Sv: Acute, Near 100% Fatality after 14 days
- 10 - 50Sv: Acute, 100% Fatality after 7 days

Current Annual Occupational Limits

1. Skin (including hands/feet) – 500 mSv for workers, public 50 mSv
2. Eye – 150 mSv for worker, public 15 mSv
3. Abdomen of female – 13 mSv in any 3 months period

____ Limits for Adults: [must not exceed 0.05 Sv per year, individual organ or tissue other than the lens of the eye must not exceed 0.5 Sv per year and lens of not more than 0.15 Sv per year.

____ Limits for Minors [10% of adult exposure limits]

___ Embryo or Fetus for Women Who Have Declared Pregnancy: [pregnant woman shall not exceed 5 mSv, not more than 0.5 mSv be received by the embryo or fetus in any one month.

___ Limits for individual members of the Public exposure: 1 mSv in a year (0.02 mSv per hour).

Internal radiation:

1. It is the principal hazard encountered in the use of unsealed radioactive materials.
2. There is no shielding and distance from an internal intake and the effect of the radiation occurs 24 hours/day.
3. Emissions will be dissipated in the cells of the body.
4. Certain isotopes will concentrate in particular organs.

5. Suitable controls are in place to address all significant hazards
6. Risks are kept as low as reasonably practicable (ALARP)
7. Procedures to continually review risk controls
8. Radiation dose limits for each population group must not be exceeded..
9. Dose records must be kept for each employee.
10. Dose monitoring and record keeping provided by an Independent.

Methods of contamination by internal hazards:

Internal contamination with radioisotopes can happen through various routes namely: Inhalation, ingestion, injection and absorption.

Methods of personal protection from internal radiation:

Laboratory coat, safety glasses/face shield, disposable gloves, disposable apron, appropriate radiation shield, personal dosimeter, consider finger badge for some isotopes e.g. P32, contamination monitor.

Radioactive Waste: Three routes for disposal materials:

1. Liquid waste, via disposal sink.
2. Solid waste to authorized contractor, via RPS.
3. Gaseous disposal, via authorized fume cupboard.

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Figure: Shows the different types of radiation detectors for detection radiation

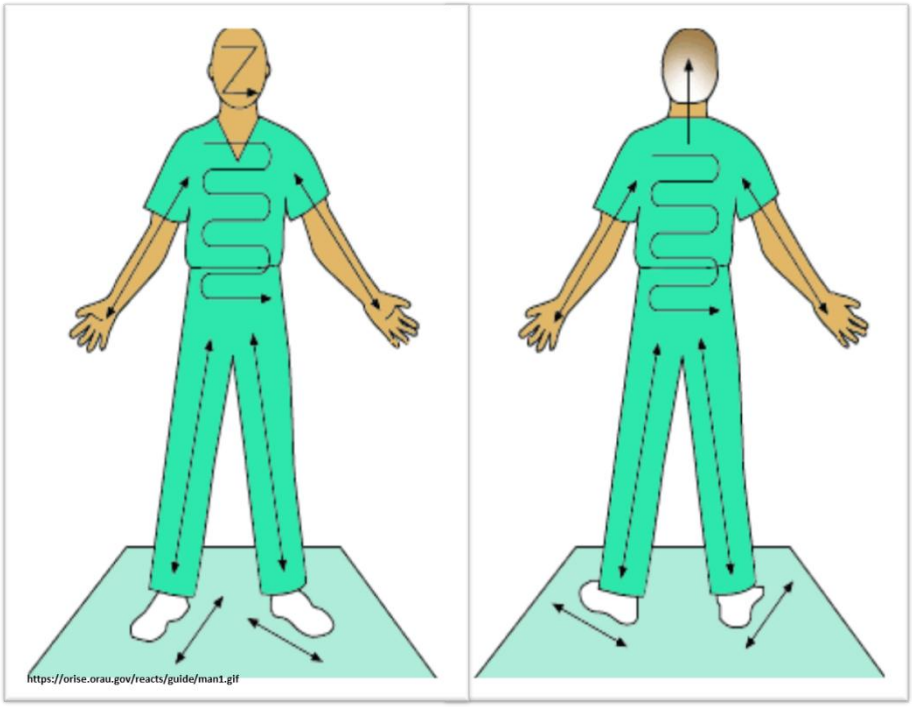

Figure 2: Pictures shows the way of measuring the radiation within the body

Figure 3: Pictures representing two different types of the personal radiation detectors