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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

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

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 or using any type of shield can be enough to get rid of the radiation.

Beta radiation can pass several meters through the air, however; using plastic shield of around 0.6 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 extra to lead.

External Radiation Protection

Several points can be done to protect the correlated 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**

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. 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.

4. Limits for children [10% of adult exposure limits]

5. Embryo or fetus for women who have declared pregnancy: [pregnant woman has not exceed 5 mSv, not more than 0.5 mSv be received by the embryo or fetus in any one month.

6. 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.

3. Gaseous disposal, via authorized fume cupboard.

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

Figure: Pictures representing two different types

of the personal radiation detectors

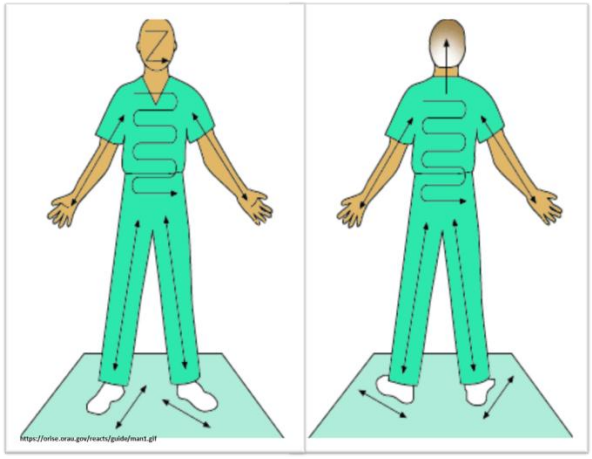

Figure: Pictures shows the way of measuring the radiation within the body