Personnel Dosimeters

Seventh Lecture (7)

First semester / Second year

By

Assist. Lec. ASAL AHMED

Personnel Dosimeters

Protection of Patients:

Regulations: are mainly concerned with the appropriate use of radiation procedures on patients by staff that has been properly trained. The use of regulations to:

1. Outline the theoretical knowledge that staff should have
2. Specify the need for practical instruction for all staff, whether they are irradiating the patient directly or carrying clinical responsibility for the patient's exposure. An individual not deemed to be fully trained may physically direct an exposure as part of their training only while under the supervision of a person who is well trained (See figure 1).

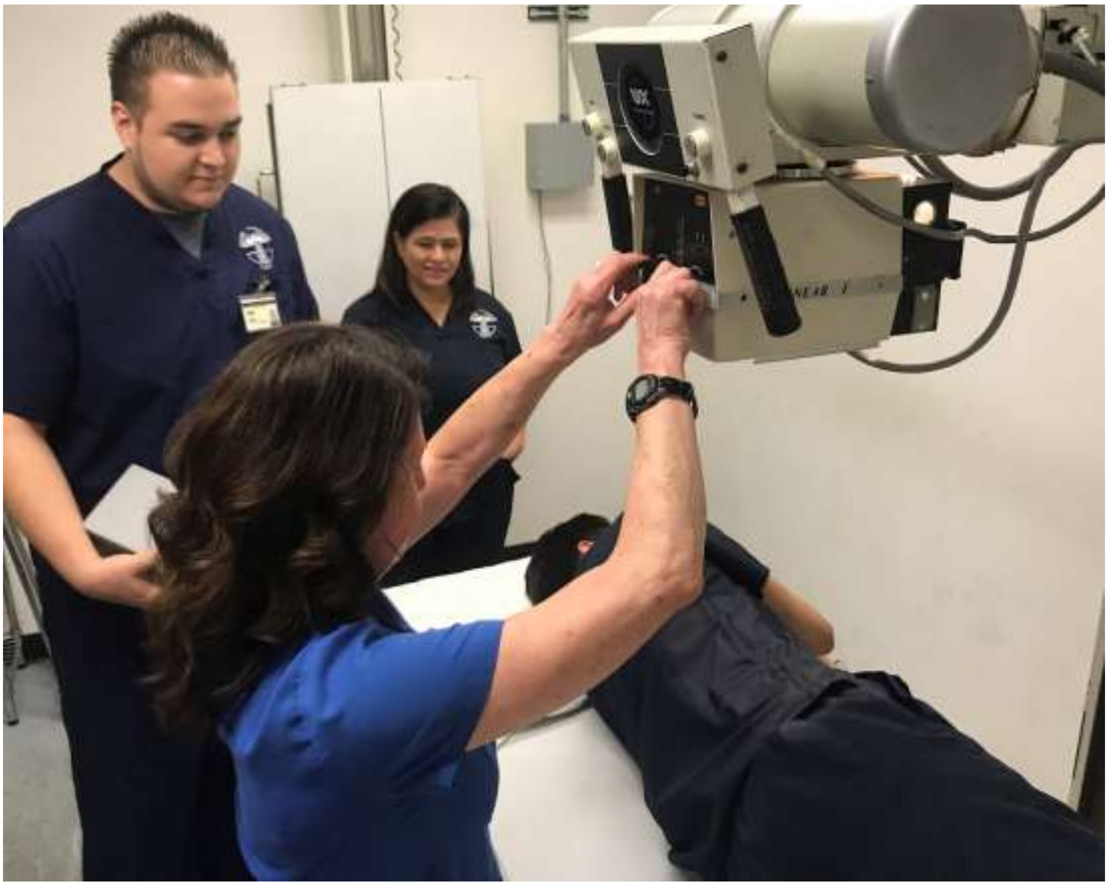

Figure (1): Shows the new technologist training by professionals.

Protection of Staff Using Devices:

Dosimetry Devices:

Radiation Dosimeter: is a device that measures the dose uptake of external ionizing radiation. It is worn by the person being monitored when used as a personal dosimeter. **Dosimetry devices are useful for keeping track of the total accumulated radiation dose; the dosimeter measures the total amount of dose you have received.**

Types of Dosimeters:

There many types of dosimeters, such as modern electronic personal dosimeters, that can be used to get:

1. A continuous readout of the ***cumulative dose*** and ***current dose rate***.
2. It can warn the wearer with an audible alarm when a specified dose rate or a cumulative dose is exceeded.

While other dosimeters, such as thermoluminescent or film types, require processing after use to reveal the cumulative dose received and cannot give a current indication of dose while being worn.

1. Film Badge Dosimeter:

Film Badge Dosimeter: is a personal dosimeter, a small portable device that is used for monitoring cumulative radiation doses due to ionizing radiation. Figure 2 shows a schematic diagram of a Film Badge Dosimeter.

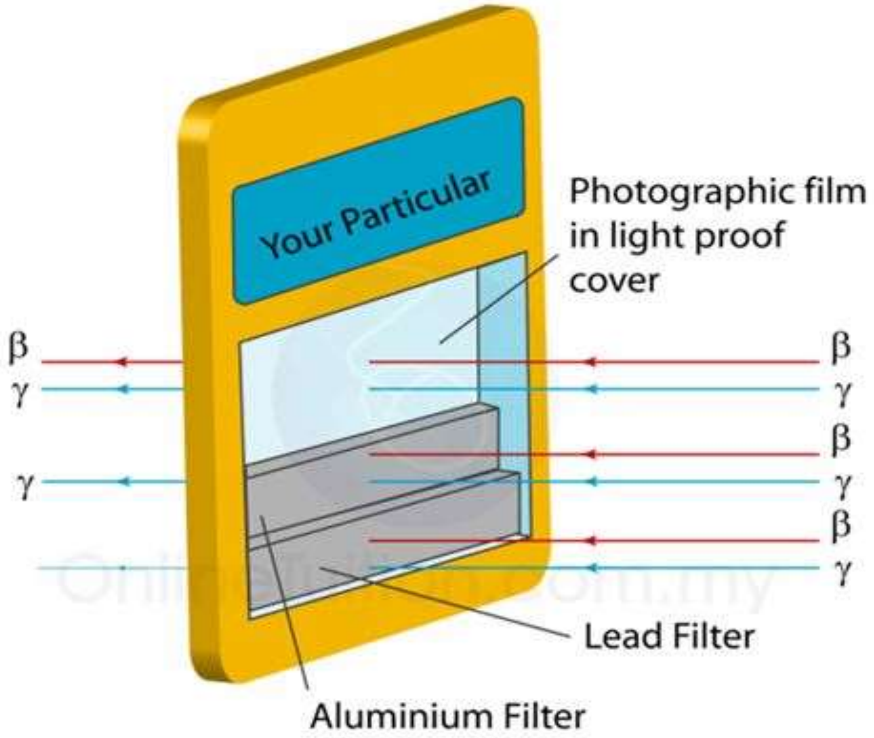

Figure (2): Shows a schematic diagram of a Film Badge Dosimeter.

The Parts of Film Badge Dosimeter:

The badge consists of two parts:

1. Photographic film: the film emulsion is black and white photographic film with varying grain sizes to affect its sensitivity to incident radiation. Some film dosimeters have two emulsions; these two emulsions can be on separate film substrates or on either side of a single substrate. Knowing the energy allows for accurate measurement of the radiation doses:
    - For low-dose measurements
    - For high-dose measurements.
2. A holder.

Advantages of the Film Badge Dosimeter:

There are two basic advantages to a film badge dosimeter:

1. The major advantages of using a film badge dosimeter to detect radioactivity are that it provides a permanent record
2. It can measure doses due to different types of radiation. All particles, such as α-particles, β-particles, γ-Rays, and X-Rays can be detected by a photographic film.

Disadvantages of the Film Badge Dosimeter:

There are two basic disadvantages to a film badge dosimeter:

1. The main disadvantage of using a film badge dosimeter is that it usually cannot be read on site and must be sent to be processed in order to prove the presence of radioactive rays. After use by the wearer, the film is removed, developed, and examined to measure exposure (See figure 3).
2. The film dosimeters are for one-time use only and cannot be reused. They are now mostly superseded by electronic personal dosimeters and thermoluminescent dosimeters.

Figure (3): Shows Film Badge Dosimeters.

2. Thermoluminescent Dosimeters (TLDs):

Thermoluminescent Dosimeters (TLDs): are types of radiation dosimeters. They are used to measure ionizing radiation, including X-Rays, gamma rays, beta radiation exposures, and neutron fields. It consists of a piece of thermoluminescent crystalline material inside a radiolucent package. This small device measures the amount of visible light emitted from a crystal in the detector. Figure 4 shows a schematic diagram of a Thermoluminescent Dosimeters, and Figure 5 Shows TLD Wrist Badge.

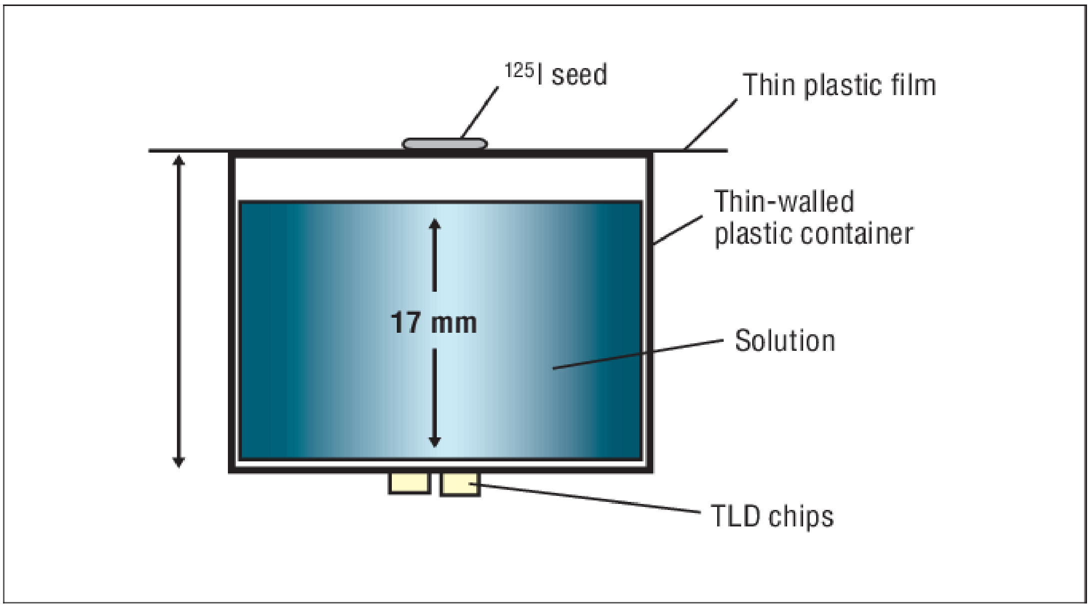

Figure (4): Shows a schematic diagram of a Thermoluminescent Dosimeters (TLDs).

*Question: How does a Thermoluminescent Dosimeter measures Radiation Exposure?

A thermoluminescent dosimeter measures ionizing radiation exposure by measuring the intensity of light emitted from a (Dy or B)-doped crystal in the detector when heated. The intensity of the light emitted is dependent on the radiation exposure. TLD emits light photons proportional to the irradiation dose when heated. ***"Irradiation"*** is the process by which an object is exposed to radiation. Depending on the impurities added to the radiation detector, TLD can respond to beta, photons of gamma and X-Rays.

Figure (5): Shows TLD Wrist Badge.

3. Optically Stimulated Luminescence (OSL):

Optically Stimulated Luminescence (OSL): is a method for measuring doses from ionizing radiation. The method makes use of electrons trapped between the valence and conduction bands in the crystalline structure of certain minerals (most commonly quartz and feldspar). The trapping sites are imperfections of the lattice, impurities, or defects. The ionizing radiation produces electron-hole pairs. Electrons are in the *conduction band*, and holes are in the *valence band.*

It is used in at least two applications:

1. **Luminescence dating of ancient materials:** mainly geological sediments and sometimes fired pottery, bricks, etc.,
2. **Radiation dosimetry:** this is the measurement of the accumulated radiation dose in the tissues of health care, nuclear, research, and other workers, as well as in building materials in regions of nuclear disaster.

NOW, What is the Equivalent Dose measurement in the OSL dosimeter?

1. The OSL dosimeter provides a new degree of sensitivity by giving an accurate reading as low as **1 mrem** for X-Ray and gamma ray photons with energies ranging from 5 KeV to greater than 40 MeV. In diagnostic imaging, the increased sensitivity of the OSL dosimeter makes it ideal for monitoring employees working in low-radiation environments and for pregnant workers, while the general read for X-Ray and gamma ray photons is **1000 rem.**
2. For beta particles with energies ranging from 150 KeV to in excess of 10 MeV, dose measurement ranges from **10 mrem to 1000 rem.**
3. Neutron radiation with energies of 40 KeV to greater than 35 MeV has a dose measurement range from **20 mrem to 25 rem.** Figure 6 shows the optically stimulated luminescence dosimeter.

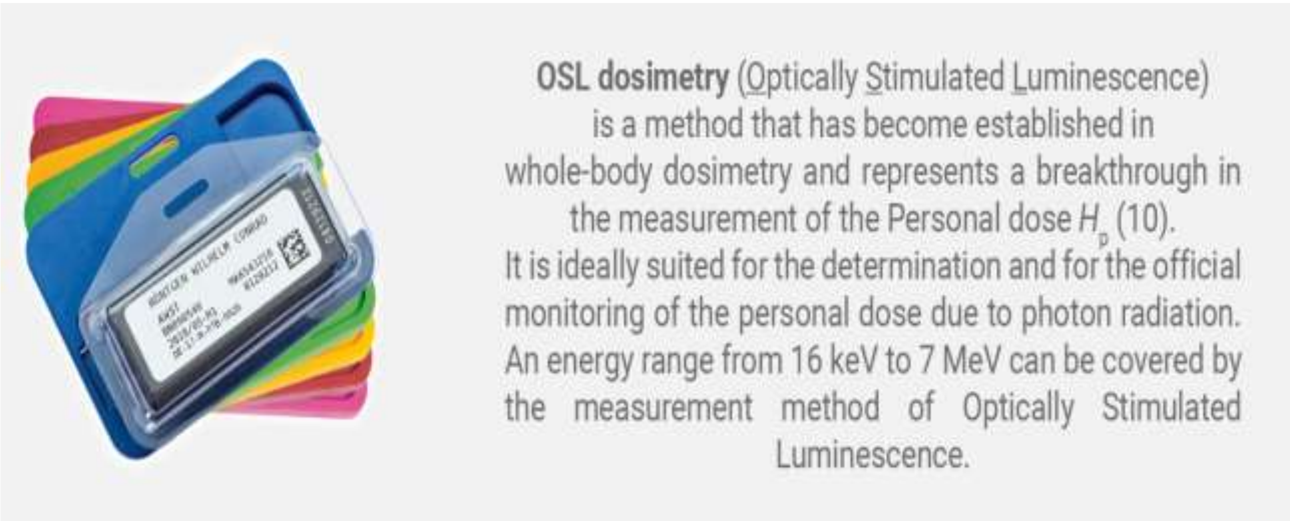

Figure (6): Shows the Optically Stimulated Luminescence Dosimeter.

4. Electronic Personal Dosimeter (EPD):

Electronic Personal Dosimeter (EPD): is a modern electronic dosimeter for estimating the uptake of ionizing radiation doses by the individual wearing it for radiation protection purposes. They are typically worn on the outside of clothing, such as on the chest or torso, to represent the dose to the whole body. This location monitors the exposure of most vital organs and represents the bulk of body mass. MOSFET dosimeters are types of EPD; they are now used as clinical dosimeters for radiotherapy radiation beams.

Figure (7): Shows a view of the readout on an electronic personal dosimeter. The clip is used to attach it to the wearer's clothing.

Advantages of the Electronic Personal Dosimeter:

The electronic personal dosimeter has the advantage over older types in that it has a number of sophisticated functions, such as:

1. Continuous monitoring, which allows alarm warnings at present levels and live readouts of doses accumulated
2. It can be reset to zero after use, and most models allow near-field electronic communications for automatic reading and resetting
3. These are especially useful in high-dose areas where the residence time of the wearer is limited due to dose constraints.