Al-Mustaqbal University
College of Health and Medical Techniques
Radiological Techniques Department

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# Radiation Protection Course

## Lecturer

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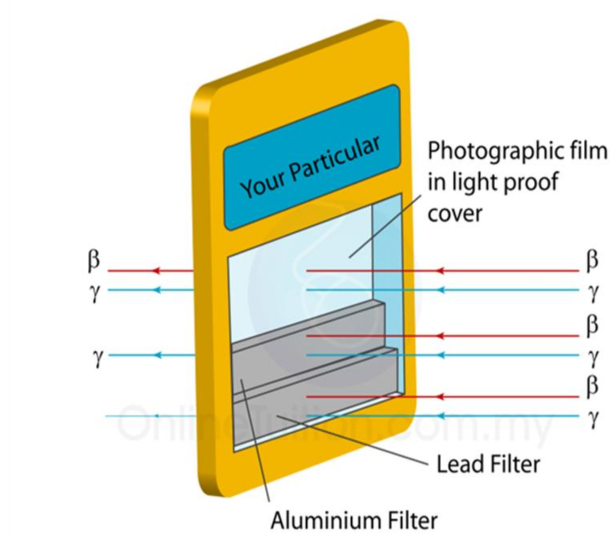
# Chapter Eight
# Personnel Dosimeters

**Introduction**: Personnel dosimeters are devices designed to measure and record the amount of radiation exposure an individual receives over a specific period. They are crucial for monitoring the radiation dose that radiation workers may encounter in their jobs, ensuring that their exposure levels remain within permissible limits. Personnel dosimeters come in various types, each serving different purposes and having distinct features. Here's a detailed overview of personnel dosimeters and their types:

1. Film Badges
2. Thermoluminescence Dosimeters (TLDs)
3. Optically stimulated luminescence (OSL)
4. Pocket Dosimeters
5. Direct Ion Storage (DIS)
6. Radio photoluminescence

**Film Badges**
A personal dosimetry film badge is a passive radiation monitoring device used to measure and record the radiation dose received by an individual over a specific period. This type of dosimeter is commonly employed in various occupational settings where workers may be exposed to ionizing radiation, such as medical facilities, nuclear power plants, industrial radiography, and research laboratories. Here's a brief overview:
**Components**: Film badges consist of a holder containing a piece of photographic film typically made of emulsions like silver bromide or silver chloride. These emulsions are sensitive to ionizing radiation. and one or more filters. Filters are placed in front of the film to alter its sensitivity to different types of radiation. Common filters include metal filters like aluminum and copper, which can help differentiate between beta and gamma radiation.
**Dosimetry Period**: Workers wear the film badge during their work shift or another designated period. The badge is then collected for analysis.

**Radiation Detection**: Ionizing radiation interacts with the sensitive film, causing changes in density. The degree of darkening or fogging on the film is proportional to the amount of radiation absorbed.
**Types of Radiation Detected**: Film badges are sensitive to various types of ionizing radiation, including gamma rays and X-rays.
**Reading and Analysis**: After the monitoring period, the film is developed and analyzed to determine the radiation dose received using a densitometer
**Advantages**: Film badge dosimeters are cost-effective, easy to use, and provide a permanent record of radiation exposure. They are also sensitive to a wide range of radiation types.
**Limitations**: Film badge dosimeters have limitations, including energy dependence, saturation effects at high doses, and a delayed processing time. Additionally, they do not provide real-time monitoring, and the wearer may not be immediately aware of exposure events.


**Thermoluminescent Dosimeters** (TLDs) (مقياس جرعات التالق الحراري): are devices used to measure and record ionizing radiation exposure. They are widely used in various industries, including healthcare, nuclear power, and radiography. TLDs offer several advantages over other dosimetry methods, and here are the key points to understand about them:
The dosimeter contains a small, crystalline TLD element. Common materials are lithium fluoride (LiF), calcium fluoride ($CaF_2$), and lithium borate ($Li_2B_4O_7$). When a TLD is exposed to ionizing radiation, electrons in the crystal lattice of the TLD material absorb energy and become excited and move to higher energy states, and trapped in crystal defects or impurities. After a period of exposure, the TLD is collected and heated. This process, known as annealing or reading, releasing the stored energy in the form of light. The intensity of the emitted light is proportional to the radiation dose received. The amount of light emitted during the heating process is measured using a photomultiplier tube or a photodiode. The resulting signal is then converted into a radiation dose value. The dose is usually expressed in units such as milliSieverts (mSv) or milliroentgens (mR).
**Advantages of TLDs**: offer high precision and accuracy in measuring radiation doses. measure both low and high levels of radiation exposure, and is reusable
**Applications:** TLDs are commonly used in medical and dental radiography, nuclear power plants, industrial radiography, and other settings where accurate measurement of ionizing radiation exposure is crucial.


**Optically stimulated luminescence (OSL):** Optically Stimulated Luminescence (OSL) is a dosimetry technique used to measure ionizing radiation exposure, similar to other methods like thermoluminescent dosimeters (TLDs). OSL dosimeters are particularly useful in situations where precise and accurate measurements of radiation exposure are required. Here are the key points to understand about Optically Stimulated Luminescence:

**Detector Material**: OSL dosimeters use materials that exhibit luminescence when exposed to ionizing radiation. Common materials include aluminum oxide (Al2O3:C) and beryllium oxide (BeO). These materials have the ability to trap electrons during radiation exposure. The crystalline structure of OSL detector materials contains defects known as oxygen centers. When exposed to ionizing radiation, electrons are trapped in these defects. The number of trapped electrons is proportional to the radiation dose received. After exposure, the OSL dosimeter is read by stimulating the trapped electrons with controlled light exposure. The stimulation causes the trapped electrons to be released and recombine with the lattice, emitting light in the process. The emitted light is measured, and the intensity is directly proportional to the amount of radiation exposure. The luminescent light emission is then converted into a radiation dose value. OSL dosimeters allow for selective stimulation of specific energy levels, enabling discrimination between different types of ionizing radiation.

**Advantages:**

OSL dosimeters offer advantages such as high sensitivity, a wide dynamic range, and the ability to discriminate between low and high-energy radiation. They are also more durable and can be worn for an extended period before readout.

**Pocket dosimeters:** are small ionization chambers and used to measure and monitor an individual's exposure to ionizing radiation. They are commonly used in environments where there is a risk of radiation exposure, such as nuclear power plants, medical facilities, research laboratories, and industrial settings.
Purpose: The primary purpose of pocket dosimeters is to measure the cumulative dose of radiation that an individual is exposed to over a specific period. This information is crucial for ensuring that radiation exposure stays within safe limits and for monitoring the health and safety of workers in radiation-prone environments. provide the wearer with an immediate reading of his or her exposure to x-rays and gamma rays. Work as ionization chamber



**Direct Ion Storage dosimeter:** **مقياس** الجرعات للتخزين الأيوني المباشر
Direct-ion storage (DIS) dosimeters are electronic dosimeters that attach to a breast pocket. DIS dosimeters use ion chambers and an electronic element to detect radiation dose levels, DIS dosimeters can operate at high radiation doses.
The direct ion storage (DIS) dosemeter is a new type of electronic dosemeter from which the dose information for both Hp (10) and Hp (0.07) can be obtained instantly at the workplace by using an electronic reader unit. The number of readouts is unlimited and the stored information is not affected by the readout procedure. The accumulated dose can also be electronically reset by authorized personnel. The DIS dosemeter represents a potential alternative for replacing the existing film and thermoluminescence dosemeters (TLDs) used in occupational monitoring due to its ease of use and low operating costs.
is: Hp (10) is the effective dose to the whole body, representing the dose received at a 10-mm depth from the skin. Hp (0.07) is the equivalent dose to the skin/extremities, representing the dose received at a 7-mm depth from the skin.

**A radiophotoluminescence dosimeter (RPLD)**: is a type of radiation dosimeter used for measuring exposure to ionizing radiation. They are a type of passive dosimeter, meaning they do not actively measure radiation in real-time but rather accumulate a dose over a period of time. RPLDs are often employed in medical, industrial, and research settings where individuals may be exposed to ionizing radiation, such as X-rays or gamma rays. Common materials use aluminum oxide ($Al_2O_3$) doped with carbon or other impurities.

It works the same as Optically stimulated luminescence