Al-Mustaqbal University
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Radiation Protection Course

Lecturer

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Chapter Four

The Principles of Radiological Protection

Introduction:

Radiological protection refers to the science and practice of protecting individuals and the environment from the harmful effects of ionizing radiation. The principles of radiological protection are based on international guidelines and recommendations established by organizations like the International Commission on Radiological Protection (ICRP) and the International Atomic Energy Agency (IAEA). These principles provide a framework for managing and minimizing radiation exposure. The fundamental principles of radiological protection are commonly summarized as:

1- **Justification**: Any exposure to ionizing radiation should be justified. This means that the benefits of the radiation exposure should outweigh the potential risks. Medical procedures involving radiation, for example, should only be performed when they are deemed necessary and when no alternative non-radiation methods can achieve the same diagnostic or therapeutic outcome.

2- **Optimization of Protection** : Also known as the ALARA principle (As Low As Reasonably Achievable) involves minimizing radiation exposure to individuals while still achieving the necessary goals. . This involves minimizing unnecessary exposure, using the least amount of radiation

necessary for the task, and optimizing the design and operation of radiation sources and facilities to reduce exposure.

a. **Time**: Reducing the time spent near a radiation source can significantly reduce exposure. Minimizing the time of exposure is a fundamental strategy in radiological protection.
b. **Distance**: Increasing the distance from a radiation source can reduce exposure. The intensity of radiation decreases with the square of the distance from the source.
c. **Shielding**: Barriers or shielding materials can be used to attenuate radiation and reduce exposure. The choice of shielding material and thickness depends on the type and energy of the radiation.

Dose Limits

Dose limitation involves setting and enforcing exposure limits for both occupational workers and the general public. These limits are typically expressed in terms of effective dose and are designed to prevent radiation-related health effects. Occupational exposure limits are generally higher than those for the general public, but they are still subject to the ALARA principle.

a- **Maximum Permissible Occupational Doses**, are established radiation exposure limits for individuals who work with or are exposed to ionizing radiation in their occupational settings. These limits are set to ensure the safety of radiation workers and to minimize the risk of harmful health effects from radiation exposure. The specific dose limits can vary depending on the country and the regulatory authority, but they are generally based on recommendations from international organizations like the International Commission on Radiological Protection (ICRP).

b- **The Maximum Permissible Public Dose**, also known as the public dose limit, is the radiation exposure limit established to protect members of the general public who are not occupationally exposed to ionizing radiation. This limit is put in place to ensure that individuals who are not involved in activities related to radiation work are not exposed to harmful levels of radiation. The public dose limit is typically set at a

much lower level than the occupational dose limit to provide an additional margin of safety.

c- **Maximum Permissible Patient Doses** refer to the radiation exposure limits or dose constraints that are established to ensure the safety of individuals receiving medical radiation procedures, such as X-rays, CT scans, radiation therapy, and nuclear medicine exams. These limits are put in place to balance the benefits of the medical procedure with the potential risks associated with radiation exposure. The specific dose limits for patients can vary depending on the type of procedure, the clinical context, and the guidance provided by regulatory bodies and medical organizations.

d- **Whole-body dose limits** refer to the maximum permissible radiation exposure that an individual can receive to their entire body over a specified period, typically in a year. These limits are set to protect individuals, especially radiation workers and members of the public, from the harmful effects of ionizing radiation. The specific whole-body dose limits can vary depending on the country and the regulatory authority but are generally based on recommendations from international organizations like the International Commission on Radiological Protection (ICRP).

Dose Limits for Tissues and Organs

Dose limits for tissues and organs are established to ensure that exposure to ionizing radiation, whether from medical procedures or occupational exposure, remains within safe levels to minimize the risk of radiation-induced health effects. These limits are typically set by regulatory authorities and organizations such as the International Commission on Radiological Protection (ICRP) and the United States Nuclear Regulatory Commission (NRC). It's important to note that dose limits can vary depending on the specific circumstances, the type of radiation, and the individual's age and radiation exposure history.

- Radiation protection for classification of exposure: involves measures and guidelines to minimize exposure to ionizing radiation and ensure the safety of individuals and the environment. Classification of exposure is an essential aspect of radiation protection, and it typically involves categorizing radiation exposure into different levels or classes based on the amount of radiation received. The primary classification of exposure in radiation protection includes:

1- Occupational Exposure:

- Occupational exposure refers to radiation exposure that occurs as a result of work-related activities. This category includes individuals who work with or around sources of ionizing radiation, such as medical professionals, nuclear workers, and industrial radiographers.
- Workers in this category are subject to specific radiation protection measures, including the use of personal protective equipment, monitoring of radiation levels, and adherence to strict safety protocols.

2- Medical Exposure:

- Medical exposure pertains to radiation exposure associated with medical procedures, such as X-rays, CT scans, and radiation therapy. Medical professionals, patients, and medical facilities must manage and minimize medical exposure.
- Radiology departments and healthcare providers must ensure that the benefit of the medical procedure outweighs the potential risks associated with radiation exposure.

3-Public Exposure:

- Public exposure involves radiation exposure experienced by members of the general public. This can occur from various sources, including nuclear power plants, environmental radiation, and radiological incidents.

  Regulatory authorities set permissible exposure limits for the general public to ensure their safety.
- Whole-body non-occupational exposure: refers to the total amount of ionizing radiation a person's entire body receives in situations outside of their workplace or professional activities. This type of exposure is typically associated with everyday life and activities and is not related to occupational radiation exposure, which occurs in the course of a person's job or profession.

The unit of measurement for radiation exposure is the sievert (Sv) or its subunit, the millisievert (mSv). When we refer to whole-body non-occupational exposure, we are talking about the cumulative dose of ionizing radiation that an individual might receive from various sources and activities over a specified period.

The sievert (symbol: Sv) is the International System of Units (SI) unit of equivalent dose, a measure of the biological effect of ionizing radiation on living tissues. It is used to quantify the potential for radiation to cause

harm to the human body. The sievert takes into account the type of radiation (e.g., gamma rays, alpha particles, beta particles) and the sensitivity of different tissues and organs to radiation.

- Partial-body occupational exposure: refers to situations where only a specific portion of an individual's body is exposed to ionizing radiation, rather than the whole body. This can happen in various occupational settings, such as in medical radiation therapy or radiology procedures, industrial radiography, or nuclear power plant operations.