Course title: Atomic and Nuclear Physics

Week # 13

Main Topics: ICRP Codes of Practice

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Lecture Learning Outcomes:

At the end of the lecture, you will be able to:

(i) Understand the basics of occupational exposure to human beings
(ii) Explain radiation protection systems and standards
(iii) Describe ICRP codes and practices

Radiation exposure

Radiation exposure implies the quantity of absorption of ionizing radiation or a hazardous substance that has been ingested, inhaled, or in contact with the skin. Acute exposure means the introduction of radiation occurs over a short period of time. Scanning using x-rays (CT scan), radiation therapy etc. are examples of acute exposure. In chronic exposure radiation exposure is received over a long period of time, such as for a lifetime. People living in high background radiation area is an example.

Human beings are continuously exposed to natural radiation and the exposure to it is inevitable. It occurs at varying levels depending on several factors like the location, altitude, occupation, and the like. Apart from the natural sources human being are exposed to man-made radiations. X-rays, C T scan and all nuclear diagnostic and therapeutic methods results in nuclear radiation exposure.

Radiations can affect the tissues in living things by depositing energy in them. Therefore, it may pose health risks by damaging tissues and DNA in genes. When the radiation has sufficient energy to affect the atoms in living cells and thereby damage their genetic material (DNA), in most cases the cells in our body are capable of repairing the damage.

The effects of radiations on living things vary with the amount of energy (dose) deposited in them. At very high doses, radiation can damage the normal functioning of tissues and organs. It can produce acute effects such as nausea and vomiting, skin redness, hair loss, acute radiation syndrome, local radiation injuries (also known as radiation burns), or even death. Exposure to radiation can result from natural sources (major source is radon in homes), planned (medical, occupational) or accidental situations. Exposure may also get from external (with or without contamination of skin, hair, clothes), internal (inhalation, ingestion or via a contaminated wound), or a combination of both.

Occupational Radiation Exposure

Potential exposure of human beings to ionizing radiations as part of the occupation in the workplace is called occupational radiation exposure. Radiation exposure can occur in several work-related surroundings, such as nuclear power plants, nuclear and scanning medical facilities, nuclear or isotope research laboratories, industrial operations using radioactive materials.

Exposure to ionizing radiations may occur due to the presence of alpha and beta particles, neutrons, heavy ions, gamma rays, and X-rays in the occupational setting. These radiations may have enough energy to ionize atoms in the organs of human body and potentially cause damage to living tissues.

Employees in the nuclear engineering, radiology, and certain manufacturing processes involving radioactive isotopes may have risk of occupational radiation exposure. Radiologists and radiologic technologists, in health care profession are routinely exposed to ionizing radiation during the performance of medical examinations and procedures.

Regulatory bodies and international organizations have established radiation dose limits to safeguard workers from the harmful effects of radiations. These limits are intended to confirm that occupational exposure remains below the specified levels that may cause increased health risks.

Employees in radiation-prone environments have to wear dosimeters to quantity and monitor their exposure to radiation. Radiation dosimetry helps safeguard individuals do not exceed established radiation dose limits due to their occupation.

Numerous mandatory protective procedures are implemented to minimize occupational radiation exposure. Use of shielding materials, maintaining safe distances from radiation sources, and engaging automation to lessen human presence in high-radiation risk areas are some of them.

Since human body is insensitive to nuclear radiations, proper training and education of workers are essential to make them aware about the risks associated with radiation exposure and to inculcate safety practices at work place.

Employees in radiation-zone during their occupation have to often undergo regular health monitoring against any potential health effects. Institutions using radioactive materials however small it may be, have to implement comprehensive radiation protection programs. These programs include implementation of policies, procedures, and safety protocols

intended for minimizing occupational radiation exposure and ensuring the overall safety of workforces. Effective management of occupational radiation exposure involves a combination of regulatory supervision, monitoring, protective procedures, and continuing instruction to ensure the well-being of individuals working in environments with ionizing radiations.

Radiation protection

In the case of a radiation emergency, general public should follow directions from local competent authorities and comply with urgent protective activities to minimize the risk of radiation exposure. The three main principles to follow are to “Get in, stay in. and tune in”. That is as far as possible be inside of the dwelling and wait for the instructions.

If you have been directed to stay inside, do so. In general walls and ceilings of our dwellings can provide sufficient protection from radioactive fallout outdoor. Stay in rooms with windows and external doors closed. Turn off ventilation systems including air conditioners and heaters in the home. It is especially important for children to follow instructions for protective measures and to seek medical attention after a radiation emergency.

Exposure to radioactive Iodine can be treated with potassium iodide. It is a medication if taken at the right time and at the right dose, blocks radioactive iodine from entering the thyroid gland. This reduces the risk of thyroid cancer in persons aged 0-18 years.

Effects of radiations and protection

1. International Commission on Radiological Protection.

ICRP is an independent registered charity, established to advance for the public benefit the science of radiological protection, in particular by providing recommendations and guidance on all aspects of protection against ionising radiation. The ICRP system of radiological protection is based on three fundamental principles: justification, optimisation and the limitation of radiation exposure.

The principle of justification requires that any decision that changes the amount of radiation exposure should do more good than harm. Radiation protection aims to reduce unnecessary radiation exposure with a goal to minimize the harmful effects of ionizing radiation.

In the medical field, ionizing radiation has become an inescapable tool used for the diagnosis and treatment of a variety of medical conditions. Radiation protection is to prevent the occurrence of harmful deterministic effects and to reduce the probability of occurrence of stochastic effects (e.g. cancer and hereditary effects).

The objective of ICRP is to develop and promulgate internationally accepted recommendations on radiation related quantities and units, terminology, measurement procedures, and reference data for the safe and efficient application of ionizing radiation to medical diagnosis and therapy, radiation science and technology, and radiation protection.

The radiological medical practitioner has the primary responsibility for radiation protection and safety of patients. PAGs, or Protective Action Guides, are radiation dose guidelines that would trigger public safety measures, such as evacuation or staying inside, to safeguard public health after a radiation emergency has occurred. The PAGs help responders plan for and respond to radiation emergencies.

What are 4 ways people are protected from radiation?

In general, alpha, beta, gamma and x-ray radiation can be stopped by: Keeping the time of exposure to a minimum, maintaining distance from the source, when appropriate, placing a shield between yourself and the source, and protecting yourself against radioactive contamination by using proper protective clothing.

Principles of Radiation Protection

Two basic principles apply to every individual that may be exposed to radiation: (1) all radiation doses are to be kept as low as reasonably achievable (ALARA), and (2) no dose to an individual shall be allowed to exceed the appropriate individual dose limit.

What is the maximum radiation limit for ICRP?

CORAR recognizes that the ICRP's occupational annual skin dose limit of 500 mSv provides adequate protection against ionizing radiation as follows: a. The limit is highly protective against stochastic effects.

Which organ is affected by radiation?

The most radiation-sensitive organs include the hematopoietic system, the gastrointestinal (GI) system, skin, lung, vascular system, reproductive system, and brain.

What is the unit of measurement for radiation protection?

The radiation dose absorbed by a person (that is, the amount of energy deposited in human tissue by radiation) is measured using the conventional unit rad or the SI unit gray (Gy). The biological risk of exposure to radiation is measured using the conventional unit rem or the SI unit sievert (Sv).

What is the radiation limit per hour?

An hourly limit from external sources of 0.002 rem (0.02 mSv) in unrestricted areas. In addition to maintaining radiation doses below the limits set forth above, work with sources of ionizing radiation shall be planned and conducted to keep doses as low as reasonably achievable.

What are 5 effects of radiation?

At very high doses, radiation can impair the functioning of tissues and organs and produce acute effects such as nausea and vomiting, skin redness, hair loss, acute radiation syndrome, local radiation injuries (also known as radiation burns), or even death.

What are the three basic quantities of radiation measurement?

Radiation. The three common quantities used to measure ionizing radiation are exposure, (X), absorbed dose, (D), and dose equivalent, (H). These quantities are defined differently, have different applications and uses, and should not be used interchangeably by the radiation protection professional.

Codes of practice associated with radiation workers.

Codes of Practice are also prescriptive in style and may be referenced by regulations or conditions of licence. They contain practice-specific requirements that must be satisfied to ensure an acceptable level of safety in dealings involving exposure to radiation. Requirements are expressed in ‘must’ statements

Short and long-term effects of radiation exposure (cellular, whole body and population level).

Exposure to very high levels of radiation, such as being close to an atomic blast, can cause acute health effects such as skin burns and acute radiation syndrome (“radiation sickness"). It can also result in long-term health effects such as cancer and cardiovascular disease.

Radiation protection apparatus and considerations

Personal protective equipment for radiologists, radiographers, and other imaging department personnel may include: Physical protection. gloves. eye protection. masks. face shields. Ionizing radiation protection. lead aprons. thyroid shields. personal radiation dosimeters.

Departmental design including radioisotope laboratories

It is equipped with lockers, a radioactive contamination monitor, an emergency shower with an eyewash, a containment system for radioactive liquid effluents, and the means necessary to carry out personal decontamination. Room where the liquid and solid scintillation spectrometers are located

Considerations for pregnant patients during delivery of radiation therapy.

The teratogenic effects of ionizing radiation restrict the imaging modalities considered safe during pregnancy. The total cumulative exposure to ionizing radiation during gestation must not exceed 100 mGy to limit deterministic effects, including fetal death, malformation, growth restriction, and long-term disability

References:

1. International Commission on Radiological Protection (ICRP), https://www.icrp.org/
2. United states Nuclear regulatory commission (USNRC), Exposure (radiation) | NRC.gov
3. World Health Organisation Radiation and health (who.int)